MP MASTER
MA29849

201-15 FILE

ME-5084
LB 422

INSTRUCTION MANUAL

TRACKING PEDESTAL SET

J77

SCIENTIFIC-ATLANTA, INC.

INSTRUCTION MANUAL

TRACKING PEDESTAL SET

J77

When ordering parts from Scientific-Atlanta, Inc., be sure to include the equipment model number, serial number, and a description of the part.

First Edition
August 1963

Price: $3

SCIENTIFIC-ATLANTA, INC.

WARRANTY FOR TRACKING PEDESTAL SYSTEMS

Equipment is warranted to be free of defects and workmanship and shall conform to all specifications made a part of the contract or purchase order. Inspection and acceptance shall be conclusive as to fulfilling this warranty, except as to latent defects, fraud and such gross mistakes as amount to fraud; providing, however, that all claims made or to be made for any reason are made in writing within one year from date of shipment from Scientific-Atlanta's plant. Scientific-Atlanta, Inc., responsibility under this warranty shall be limited to repair or replacement of defective work or parts returned to Scientific-Atlanta, Inc., with freight charges to plant and return paid by buyer. Scientific-Atlanta, Inc., may at its option elect to correct any warranty defects by sending its supervisory or technical representative, at Scientific-Atlanta's expense, to customer's plant or location within the continental United States to make on-site corrections. SINCE SCIENTIFIC-ATLANTA, INC., HAS NO CONTROL OVER CONDITIONS OF USE, NO WARRANTY IS MADE OR IMPLIED AS TO SUITABILITY FOR CUSTOMER'S INTENDED USE, BEYOND SUCH PERFORMANCE SPECIFICATIONS AS ARE MADE A PART OF THE PURCHASE ORDER.

Sales to government and government prime contractors will be made under Inspection and Acceptance conditions of Clause 5 of Standard Form 32 and if anything in the above statement of warranty obligations is deemed to be in conflict with Standard Form 32, then conditions of Standard Form 32 shall govern.

CONTENTS

SECTION		PAGE NUMBER
1	GENERAL DESCRIPTION	
	1.1 Introduction	1-1
	1.2 Principles of Operation	1-2
	1.3 Specifications	1-4
2	INSTALLATION	
	2.1 Unpacking	2-1
	2.2 Pedestal Installation	2-1
	2.3 Antenna Installation	2-3
	2.4 Control System Installation	2-4
	2.5 Cabling	2-5
	2.6 Intercom Circuit	2-5
3	OPERATION	
	3.1 Turn-On	3-1
	3.2 Interlock Circuitry	3-1
	3.3 Mode Selection	3-1
	3.4 Limit Switches and Indication	3-2
	3.5 Manual Pedestal Operation	3-3
4	DETAILED DESCRIPTION	
	4.1 Pedestal	4-1
	4.2 Servo Control System	4-3
5	MAINTENANCE AND ADJUSTMENTS	
	5.1 Pedestal	5-1
	5.2 Servo Control System	5-4
6	PARTS LIST	6-1
7	DRAWINGS AND DIAGRAMS	7-1

SECTION 1
GENERAL DESCRIPTION

1.1 Introduction

The Scientific-Atlanta Model 3102-J77 Antenna Pedestal and its associated servo control system provide precise, closed-loop automatic positioning of an antenna in azimuth and elevation. The pedestal is a servo-driven, elevation-over-azimuth, medium-duty tracking pedestal which features low weight, high rigidity, and accessibility for maintenance.

An elevation section mounted on an azimuth section comprise the Model 3102-J77 pedestal. Turntables at each end of the elevation-section housing serve as interfaces for the mounting of the antenna. The pedestal is secured to its mounting by three bolts in the bottom flange of the azimuth-section housing.

The entire pedestal is weatherproof. Thin-section cast aluminum housings, with sealed cover plates at access openings, form the weatherproof exterior. All rotating components are protected by seals against the entry of water, dust, etc., and the assembly is self-draining to prevent accumulation of moisture from condensation.

Handcranks are provided on each axis to allow manual antenna positioning.

The servo control system consists of a control unit, a servo amplifier, a position indicator unit, a power control box, and two power amplifiers. The power amplifiers are located in the azimuth section of the pedestal. Three operator-selectable modes of operation are provided by the control system--manual rate, slave, and standby. The azimuth and elevation channels are completely independent so that positioning information can be derived from different sources.

The following equipment is included in the system:

1 Model 3102-J77 Antenna Pedestal
1 Model 3611-J77 Servo Control Unit
1 Model 3620-J77 Servo Amplifier
1 Model 4711 Position Indicator Unit

1 Power Control Box, Part/Dwg. No. J77ECE2118

2 Model 3632 Power Amplifiers

1.2 Principles of Operation

Fig. 1.1 is a block diagram of the pedestal and control system. Only one channel is shown--the other is identical.

There are two operational inputs to the system. One is a slave synchro input and the second is a manual rate input derived from manual rate potentiometers located on the front panel of the servo control unit.

The slave input synchro leads are connected through the system cabling to synchro control transformers located in the pedestal. Any difference in the rotor positions of the two sets of synchros results in an ac error signal which is converted to dc by a demodulator unit in the servo control unit.

The dc manual rate signal and the slave error signal which has been converted to dc are applied through mode-selector relays to dc amplifiers in loop-compensation networks located on a dc amplifier unit in the servo control unit. The compensated dc error signal for both modes is applied to the servo amplifier unit where servo control amplifiers produce firing pulses for control of the power amplifiers as a function of the dc signal.

Firing pulses produced by the servo control amplifiers are applied to silicon controlled rectifiers in the power amplifiers which control both the magnitude and polarity of the power applied to the drive motors. A dc tachometer, which is an integral part of each of the ac drive motors in the pedestal, generates a voltage proportional to motor speed which is used for rate control and servo-loop stabilization. In addition to the 1:1 synchro control transformer utilized in connection with the slave mode, a 1:1 synchro transmitter is geared to each axis to provide position indication and a slave output signal. The latter can be used as a slave input signal for other tracking systems if desired.

1.3 Specifications

1.3.1 Pedestal

GENERAL

Pedestal Type	Elevation over azimuth
Weight	850 pounds
Height (Base to Elev. Axis)	48 inches
Base Diameter of Pedestal	29-1/2 inches
Elevation-to-Antenna Interface	Left and right elev. turntables, 12.5-inch bolt circle, 8 holes, 1/2-inch tapped, equally spaced
Elevation Turntable Diameter	14 inches

OPERATIONAL

Rated Speed	15°/sec
Slew Speed	22°/sec
Acceleration	$15°/sec^2$
Max. Delivered Torque	1000 ft-lb
Intermittent Stall Torque	1260 ft-lb
Withstand Torque	2000 ft-lb
Static Accuracy	±0.2°
Dynamic Accuracy	±0.05°/rpm (cumulative with static accuracy)
Elevation Travel	-1° to +92°
Azimuth Travel	±360°

MECHANICAL

Drive Package, Both Axes	400-watt, 2-phase, low-inertia servomotor with dc tachometer. Oil-bath-lubricated, 3-stage, spur-gear reducer equipped with a spring-loaded magnetically released brake.
Gear Ratio, Both Axes	840:1
Azimuth Bearing	23 inch-diameter, four-point-contact ball bearing

Azimuth Drive Gear	Internal gear integral with bearing
Elevation Bearing	Two 9 inch-diameter, four-point-contact ball bearings
Elevation Drive Gear	Enclosed spur gear
Drive Torque, Both Axes	1000 ft-lb continuous
Mechanical Backlash	0.03° maximum
Limit Switches and Stops	
Azimuth	±360° adjustable
Elevation	-1° to +92°, adjustable, with resilient stops at approx. -5° and +185°
Data Pickoff (Each Axis)	One 23CT6 synchro at 1:1, one 23TX6 synchro at 1:1

ENVIRONMENTAL

Temperature	
Operational	-30°F to +140°F
Non-Operational	-65°F to +140°F
Humidity	100% plus condensation and rain
Atmosphere	Salt atmosphere

1.3.2 Servo Control System

No. of Channels	Two, independent
Type Drive	Two-phase ac servomotor with SCR power amplifier
Modes of Operation	Standby Slave Manual Rate
Inputs	
Standby	System disable
Slave	1:1 synchro transmitter
Manual Rate	DC signal from Manual Rate Control potentiometer
Rack Space Required (19-inch RETMA)	Servo Amplifier: 5-1/4 inches Control Unit: 5-1/4 inches Indicator Unit: 5-1/4 inches
Power Requirements	115v ac, 60-cycle, 4-wire, 3 phase, 5 kva

SECTION 2
INSTALLATION

2.1 Unpacking

Remove the equipment from the shipping containers and inspect for damage incurred during shipment. The electronic units contain plug-in circuit boards and relays; these components should be firmly seated in their sockets before operating the system.

2.2 Pedestal Installation (See Fig. 2.1)

NOTE: Each Tracking Pedestal System is designed to accomodate a specific antenna load. The mechanical elevation stops on each pedestal are adjusted for the correct inertial load and the elevation turntables are marked accordingly for the specified number of slug-feet-squared. In addition, the control system for each pedestal has been adjusted and compensated for the correct load. Be sure to install the control units for each system with their respective pedestals, and be sure to install the correct antenna load on each pedestal.

The pedestal must be leveled and firmly mounted to a base provided by the customer with three anchor bolts through the bottom mounting pads in the flange of the azimuth housing. After positioning the pedestal in place, leveling can be accomplished by placing a spirit level on the turntable covers at the bottom of the elevation section and shimming under the three azimuth mounting pads.

NOTE: When shimming make sure that the mounting surfaces are in one level plane to prevent distortion of the base structure when the mounting bolts are tightened.

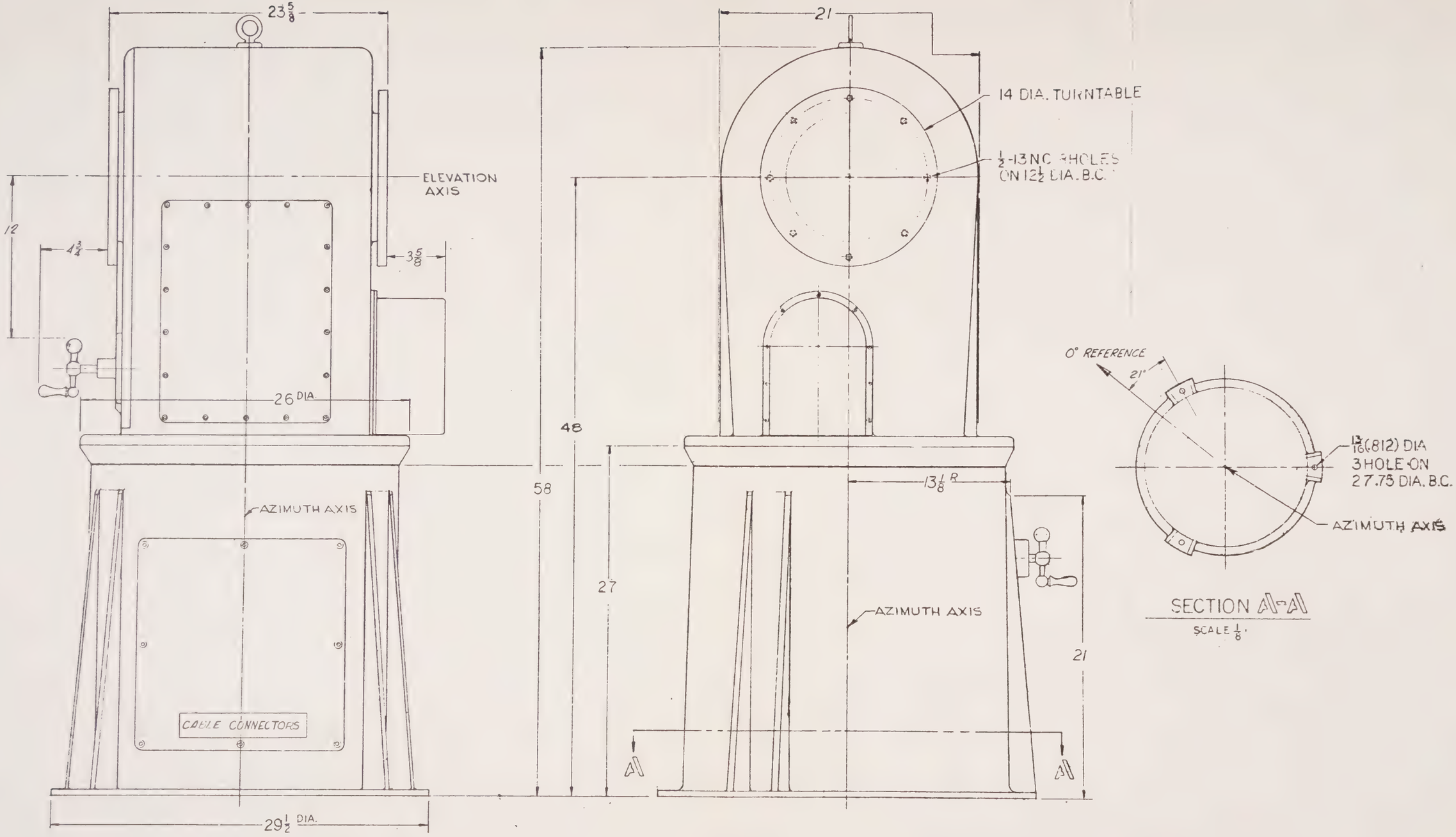


Fig. 2.1. Pedestal Dimensions and Installation Drawing

After the base level is established and proper shimming is made, tighten the three anchor bolts.

The azimuth limit switches are set at the factory for a travel of ±360° from the stow-lock position (see Section 5 for adjustments).

The pedestal can be lifted with the eyebolt on the elevation assembly.

CAUTION

Avoid extreme shock forces when maneuvering the pedestal with the eyebolt.

2.3 Antenna Installation (See Fig. 2.1)

A mounting fixture must be fabricated to secure the antenna to the pedestal. The fixture is attached directly to the two elevation turntables with 1/2-13 UNC bolts. The bolt-circle diameter is 12.5 inches and contains eight equally spaced 1/2-inch tapped holes.

A "V" has been stamped in one or both elevation turntables. When this mark is at the uppermost point, the antenna should be positioned horizontally; the elevation travel sector is −1° forward (depress) and +92° reverse (past the zenith). The mechanical stops will arrest motion approximately 5 degrees beyond these limits.

It is recommended that an antenna counterbalance be provided. It may be in the form of heavy fins--for wind and weight counterbalance--or a simple weight, as desired.

Make sure that the antenna will not strike the pedestal body when the antenna is depressed to its forward limit. The pedestal can be mounted on an extension section to provide ground clearance if necessary.

Electrical connections are made to the pedestal through four cables. The connectors are keyed to prevent a wrong connection. A 117v ac, 60 cps, convenience

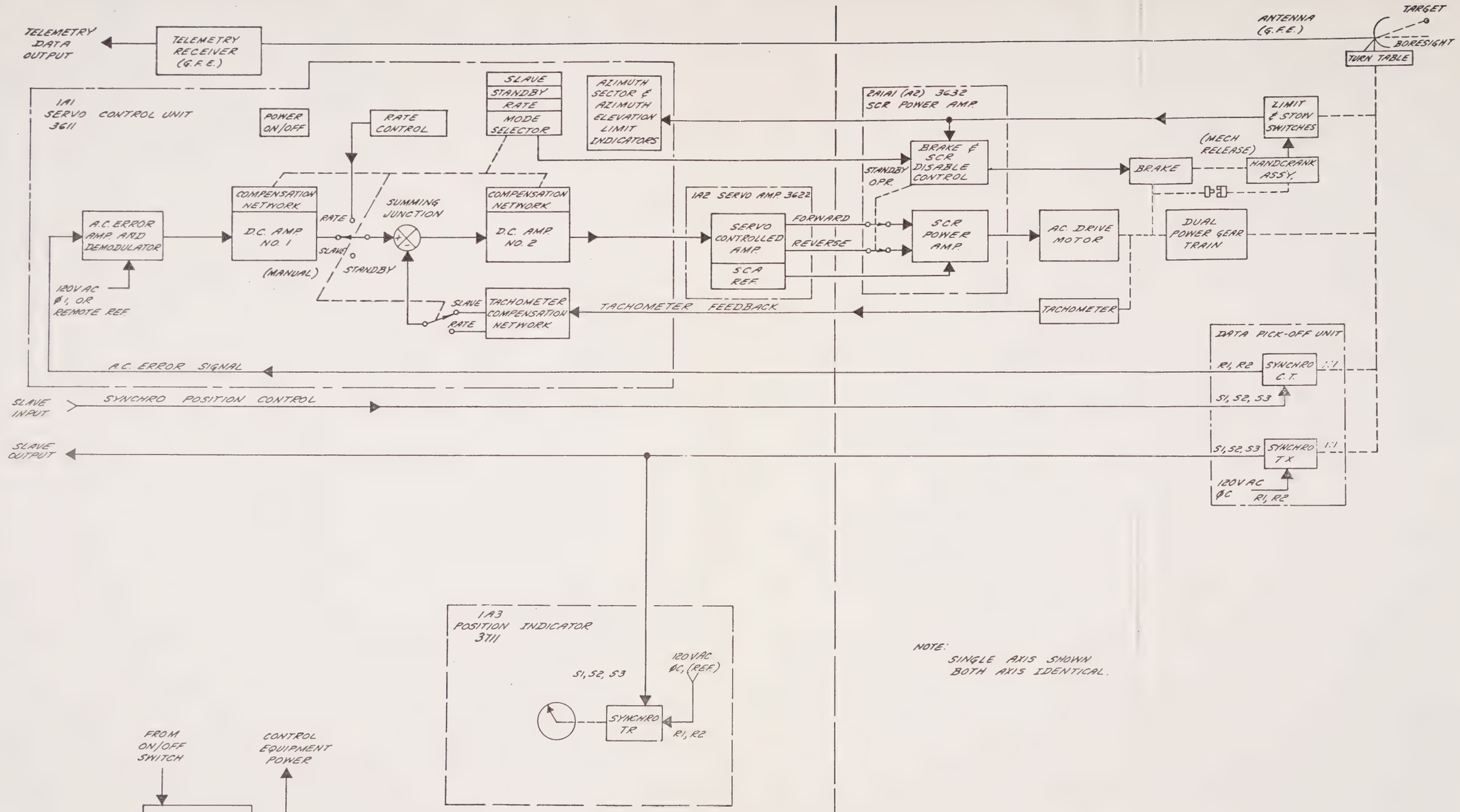


Fig. 1.1. Tracking Pedestal Set J77 Block Diagram

outlet is provided on the pedestal for operating small tools, test equipment, etc. A standard commercial three-wire intercom jack is mounted in the cable area. The remote end of the intercom circuit is at the control unit (see paragraph 2.6).

A safety switch is located near the convenience outlet.

Refer to the schematic diagram, Fig. 7.7 for detailed wiring information.

2.4 Control System Installation

The electronics in the system consist of three rack-mounted chassis; the pedestal servo control unit, the servo amplifier unit, and the position indicator unit. The two power amplifiers are mounted in the azimuth housing of the antenna pedestal. A power control box is designed for wall mounting.

2.4.1 Power Amplifier

The power amplifiers are mounted in the azimuth housing for shipment. Before operating the system check to see that any packing material around these units for protection in transit is removed. There is a fan in each of the power amplifiers and the area immediately adjacent to the fans should be cleared to allow an unrestricted flow of air into these units. Two cables connect to the power amplifiers. These cables should be connected when the system is unpacked. The cables are keyed such that they cannot be incorrectly connected.

2.4.2 Power Control Box

The power control box is designed for wall mounting and a short length of cable is supplied to connect it to the servo control unit. The power control box may be mounted at any convenient location within the cable length from the pedestal servo control unit.

Cable W11, which provides the prime power input into the system, is not furnished by Scientific-Atlanta (see Fig. 2.9). This cable, which supplies 208/120v ac, 60-cps, 4-wire power to the system, should be connected into the power control box as follows: The ac power connected to the terminal in the power control box marked 'Phase A' must lead in phase the power applied to the terminal marked

"Phase B" by 120°. This connection is essential for proper operation of the system. Instructions for connection are located inside the power control box.

2.4.3 Rack-Mounted Electronic Units

Of the three cabinet-mounted units, two, the servo control unit and the servo amplifier, are equipped with rack slides of EMCOR type. The position indicator unit, because of its light weight, is not equipped with rack slides and is secured in the cabinet by the front-panel mounting screws.

All units are designed for mounting in a standard 19-inch relay rack. Mounting locations of the units with respect to each other is unimportant. The prime consideration should be accessibility to the operator.

The pedestal servo control unit and the servo amplifier unit contain solid-state circuitry and placement above heat-producing equipment such as power supplies, power amplifiers, etc., should be avoided.

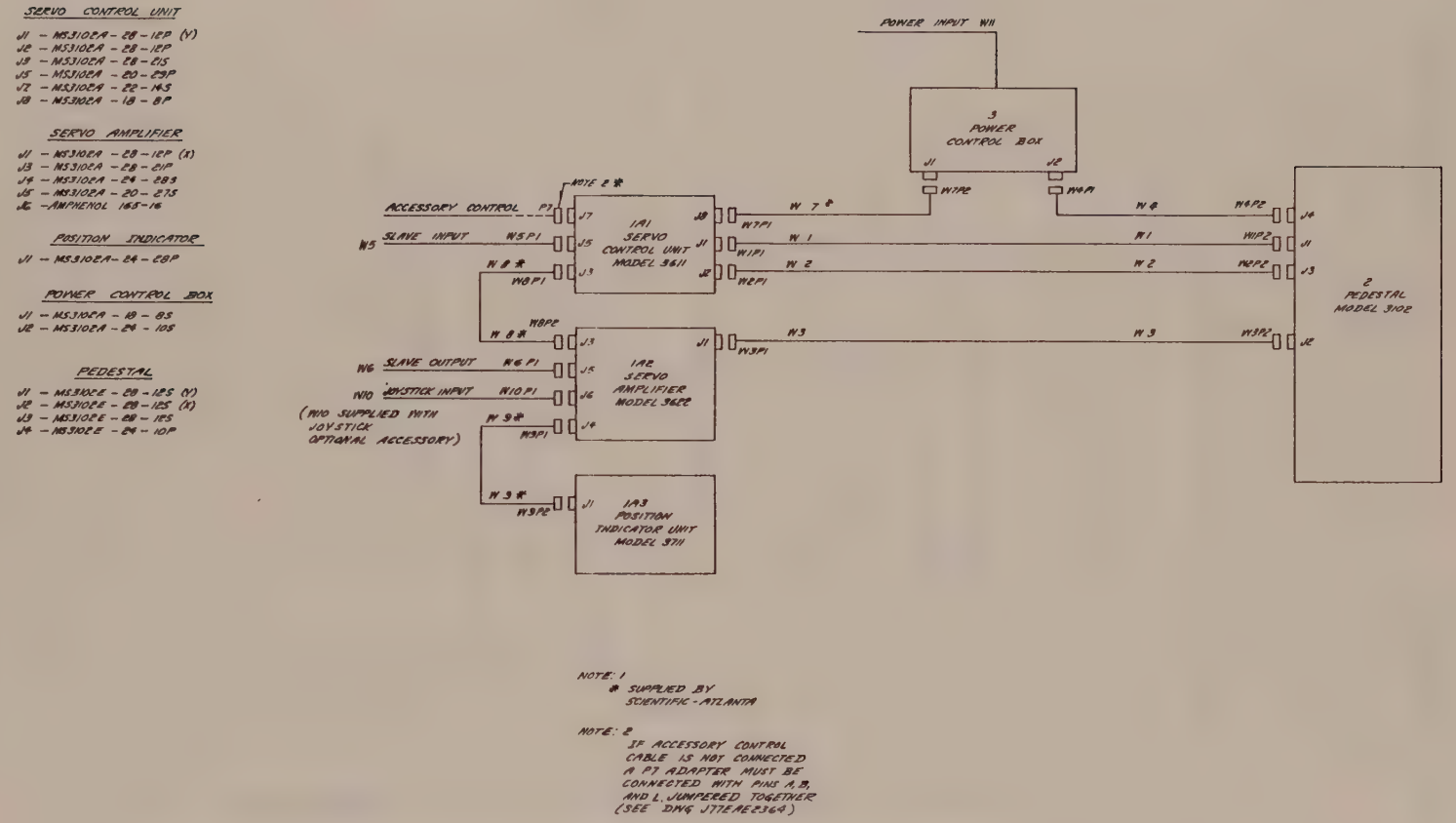
2.5 Cabling

Fig. 2.2 is a diagram of the cabling required to put the system into operation. The only cables supplied as a part of this system are W7, W8, and W9. The information necessary for construction of the balance of the cables is located at the rear of this Section (see Figs. 2.3 through Fig. 2.9).

All system cables should be thoroughly checked before applying power to the system. In particular, the input power cable into the power control box should be checked to ensure that the proper phase relationship as described in paragraph 2.4.2 is correct. It is recommended that the operator read and understand Section 3 of this manual before applying power to the system.

2.6 Intercom Circuit

A shielded-pair intercom circuit is terminated on pins A, B, and E (shield) of connector J7 of the control unit. The circuit is wired to a three-wire intercom jack on the pedestal azimuth section.



NOTE: 1
* SUPPLIED BY SCIENTIFIC-ATLANTA

NOTE: 2
IF ACCESSORY CONTROL CABLE IS NOT CONNECTED A P7 ADAPTER MUST BE CONNECTED WITH PINS A, B, AND L JUMPERED TOGETHER (SEE DWG J77EAE2364)

Fig. 2.2. System Cabling Diagram

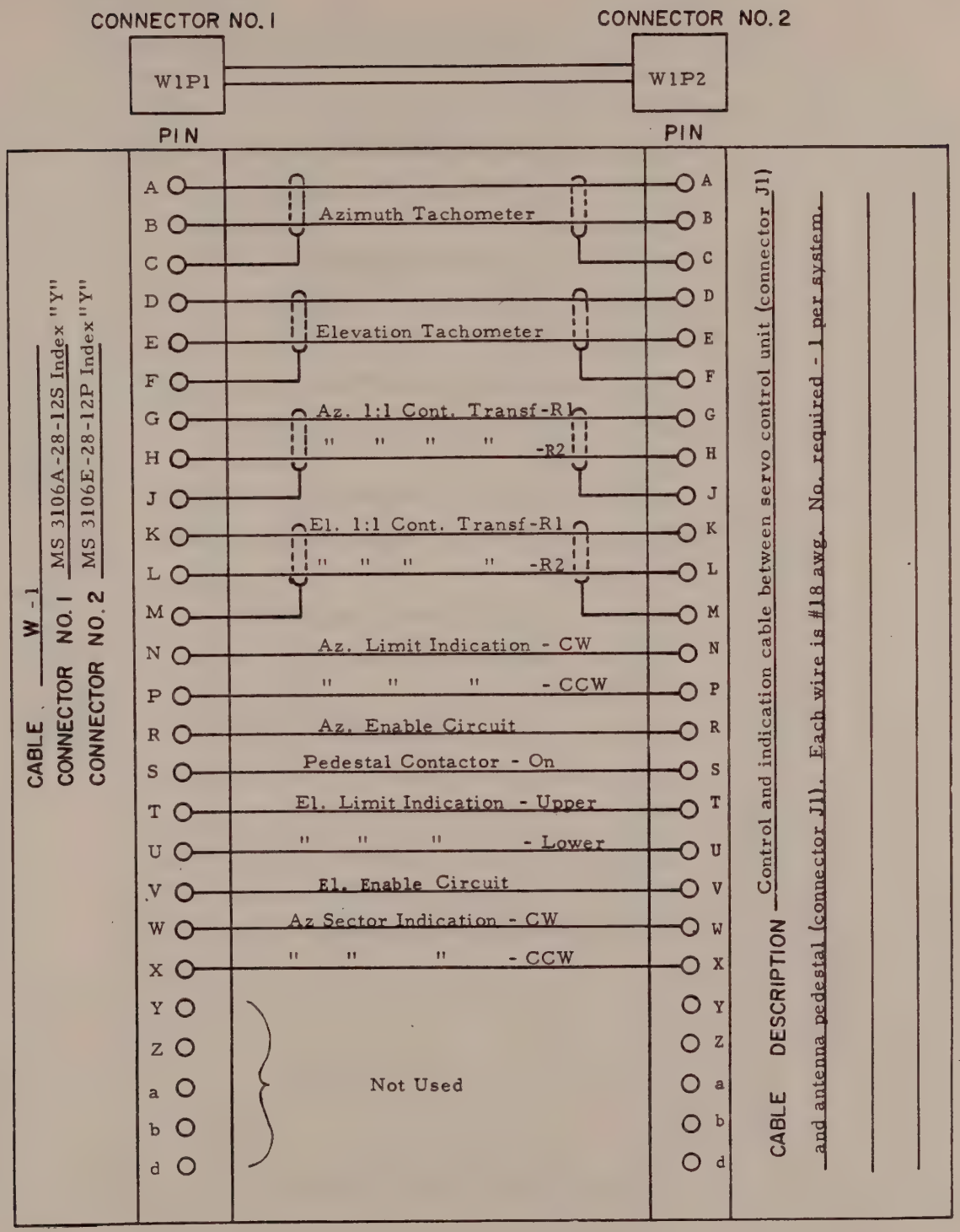


Fig. 2.3. Cable W1 Fabrication

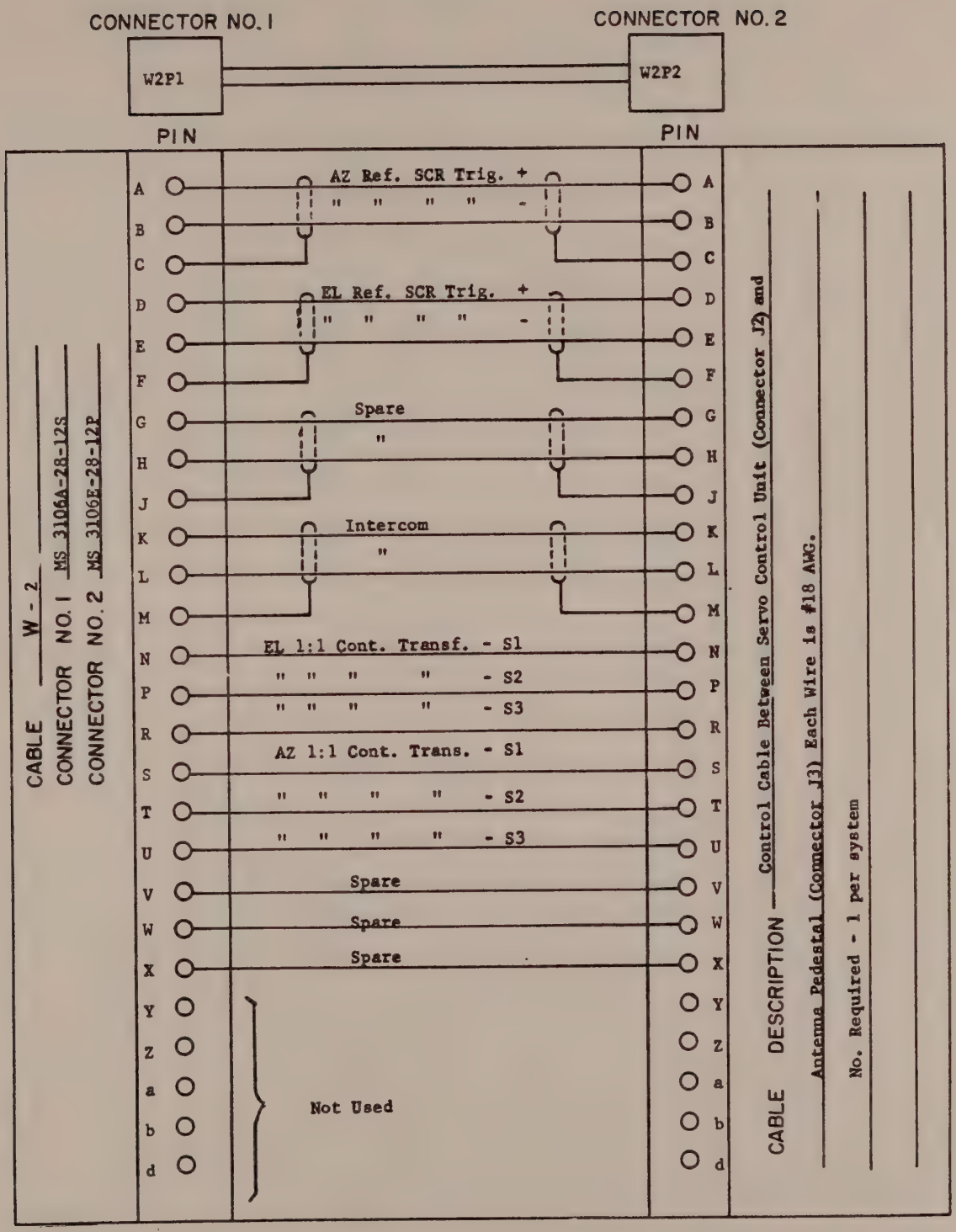


Fig. 2.4. Cable W2 Fabrication

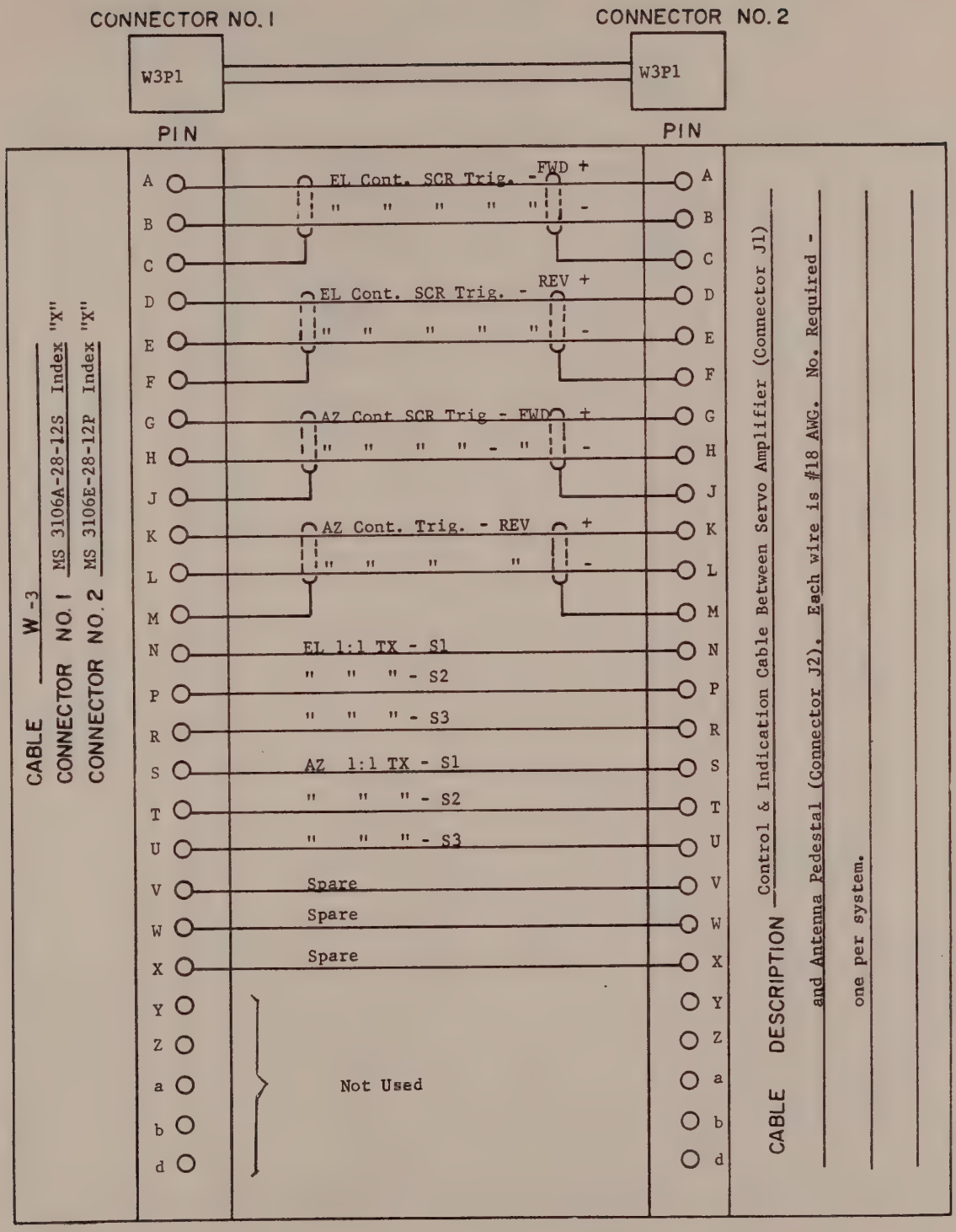

CONNECTOR NO. 1
CONNECTOR NO. 2
W3P1
W3P1
PIN
PIN
CABLE W-3
CONNECTOR NO. 1 MS 3106A-28-12S Index "X"
CONNECTOR NO. 2 MS 3106E-28-12P Index "X"
EL Cont. SCR Trig. - FWD +
" " " " " -
EL Cont. SCR Trig. - REV +
" " " " " -
AZ Cont SCR Trig - FWD +
" " " " - " -
AZ Cont. Trig. - REV +
" " " " -
EL 1:1 TX - S1
" " " - S2
" " " - S3
AZ 1:1 TX - S1
" " " - S2
" " " - S3
Spare
Spare
Spare
Not Used
CABLE DESCRIPTION Control & Indication Cable Between Servo Amplifier (Connector J1)
and Antenna Pedestal (Connector J2). Each wire is #18 AWG. No. Required -
one per system.

Fig. 2.5. Cable W3 Fabrication

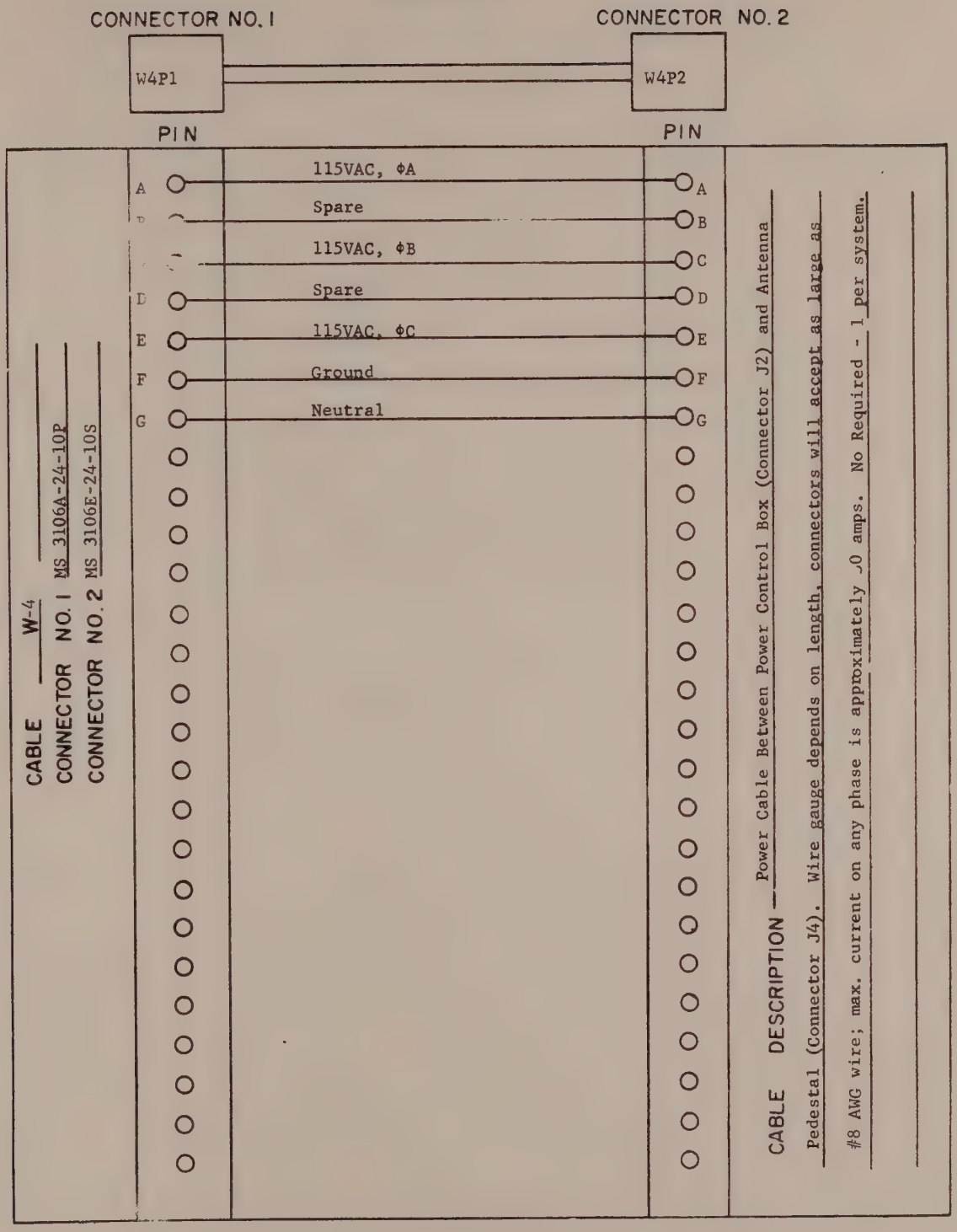


Fig. 2.6. Cable W4 Fabrication

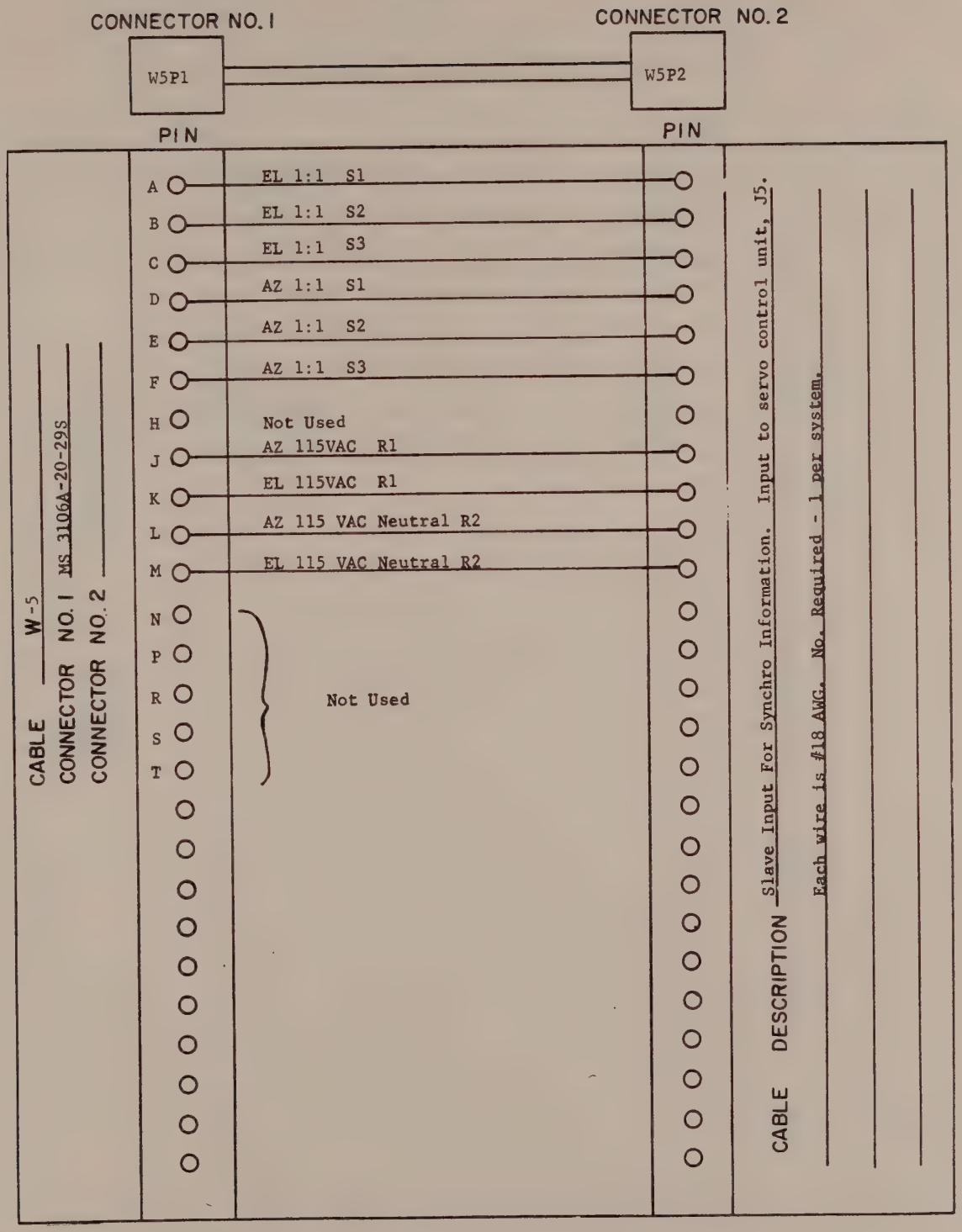


Fig. 2.7. Cable W5 Fabrication

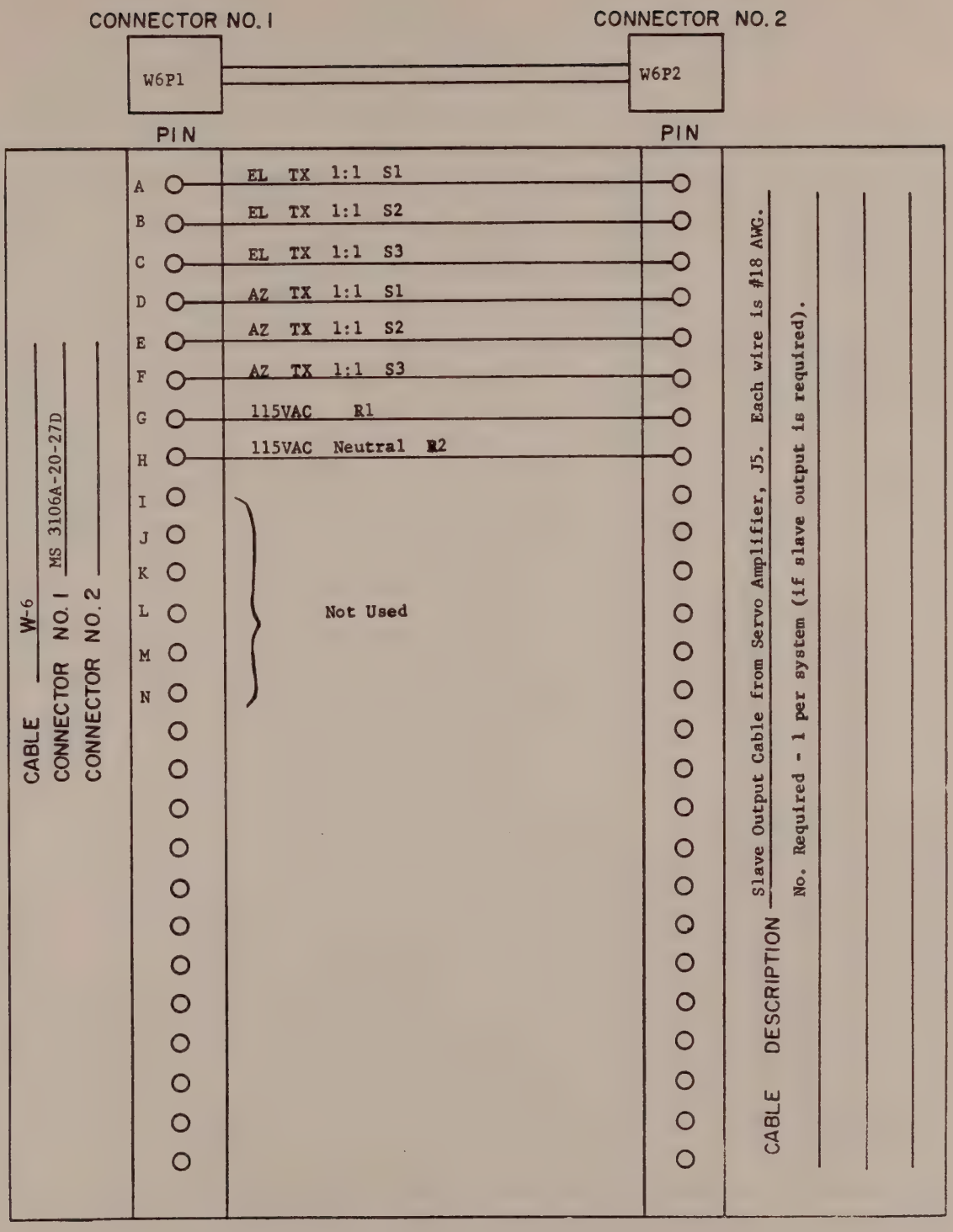


Fig. 2.8. Cable W6 Fabrication

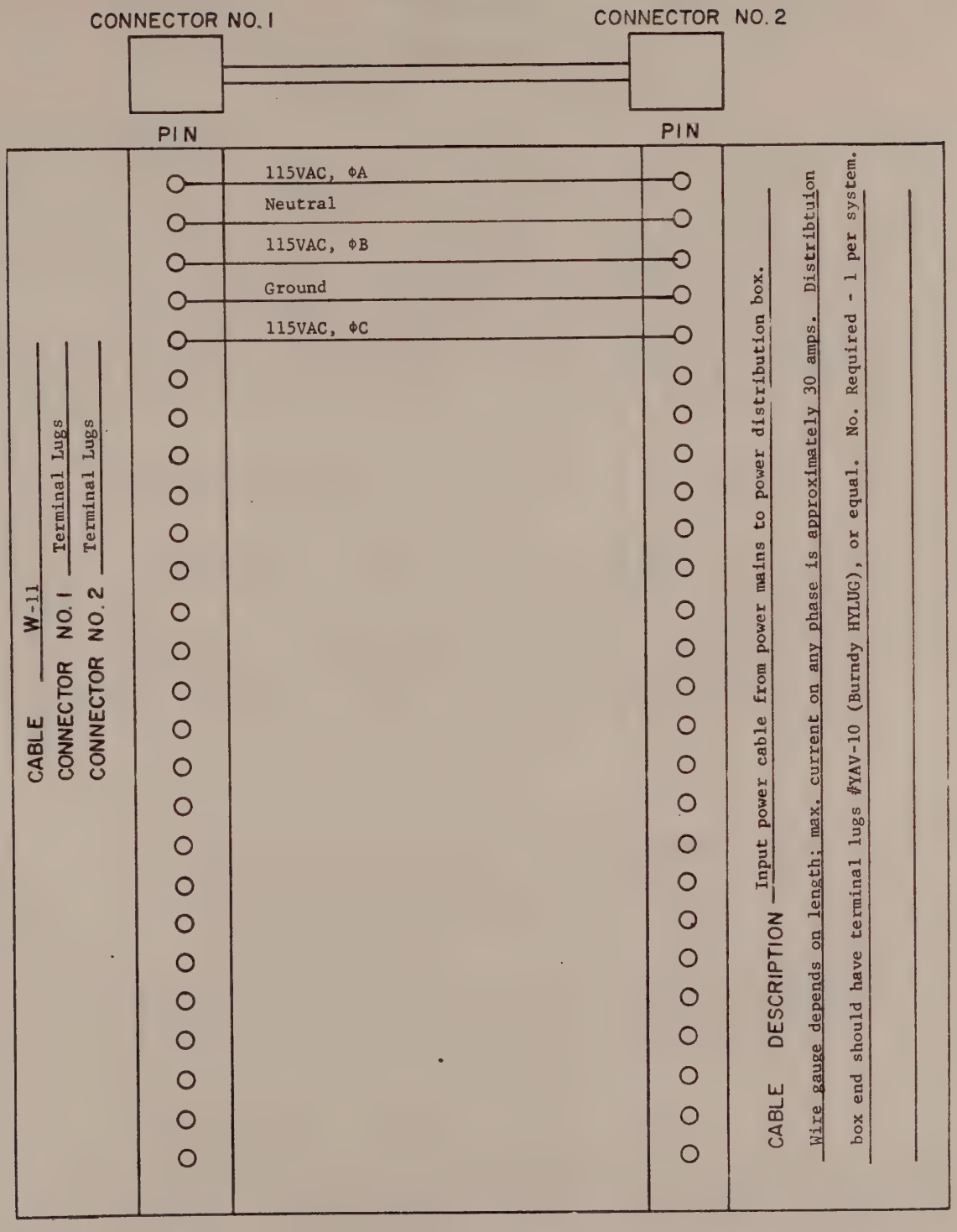

CONNECTOR NO. 1
CONNECTOR NO. 2
PIN
PIN
115VAC, ΦA
Neutral
115VAC, ΦB
Ground
115VAC, ΦC
CABLE W-11
CONNECTOR NO. 1 Terminal Lugs
CONNECTOR NO. 2 Terminal Lugs
CABLE DESCRIPTION Input power cable from power mains to power distribution box.
Wire gauge depends on length; max. current on any phase is approximately 30 amps. Distribtuion
box end should have terminal lugs #YAV-10 (Burndy HYLUG), or equal. No. Required - 1 per system.

Fig. 2.9. Cable W11 Fabrication

SECTION 3
OPERATION

3.1 Turn-On

With the system properly connected by cables as described in Section 2, the system is turned on by pressing the POWER button on the servo control unit. Pressing this button causes a magnetic contactor in the power control box to be energized which applies power throughout the system. The correct indication upon turning on the power is illumination of the POWER button and the two STANDBY buttons in azimuth and elevation as well as one of the SECTOR indicators.

3.2 Interlock Circuitry

The system is provided with adequate interlocks for safety of personnel operating the equipment. One such interlock is the antenna safety switch which is located with the antenna pedestal power input connector on the large door of the azimuth housing. Placing this switch in the SAFE position prevents electrical operation of the system by disabling the drive circuits and applying the brakes.

CAUTION

The pedestal safety switch merely disables the drive system and does not remove the ac power from the pedestal.

Interlocks are also provided on the manual handcranks and stow locks of each axis of the pedestal. Refer to paragraph 3.5 for further information.

3.3 Mode Selection

Selection of modes in azimuth and elevation are completely independent of each other. That is, any mode for one axis may be selected while the same mode or any other mode may be selected for the other axis.

To select a given mode press the MODE SELECTOR button for that axis.

Actuation of a mode-selection button causes all the circuits necessary to operate in that mode to be completed automatically.

If the SLAVE mode is selected for either axis, the system is then controlled by the external synchro transmitters which are connected in the system through slave input connector J2 of the servo control unit.

In the MANUAL RATE mode, the system is controlled from the RATE potentiometers on the front panel of the pedestal servo control unit.

In the STANDBY mode the system is made inoperable by disabling the power amplifiers and by applying brakes to the axis selected.

3.4 Limit Switches and Indication

3.4.1 Azimuth

The azimuth axis of the pedestal is equipped with two separate limit switches (primary and secondary) which function independently. The limit switch circuitry is arranged so that actuation of either of the primary limit switches prevents further rotation in that direction, that is, actuation of the clockwise limit switch prevents the pedestal from rotating further in a clockwise direction. Actuation of a primary limit switch disables the silicon controlled rectifiers (SCR's) in the power amplifier and applies the brake.

Reversal out of the limit may be accomplished by any means which reverses the error signal into the preamplifier circuitry. For example, reverse the RATE control if in the manual rate mode.

The azimuth secondary limit switches function only if the primary limit switches fail to operate. If either of the secondary limit switches are actuated, the system is disabled and no electrical backout is provided. In this case it is necessary to manually move the antenna pedestal out of the limit using the hand-cranks provided.

Limit indication is provided by two neon indicators located on the front panel of the servo control unit. No indication of secondary limit is provided.

3.4.2 Elevation

The elevation axis of the pedestal has a single set of limit switches which correspond to and whose function is exactly the same as the azimuth primary limit switches described above. Mechanical torsion bar stops provide the secondary limits on the elevation axis.

3.5 Manual Pedestal Operation

Both axes of the pedestal are equipped with stow-lock pins and handcranks. In each axis the pins may be inserted into either of two receptacles. One is a "stow-position" receptacle which mechanically prevents the axis from moving when the pin is inserted, and the other is an "operate" receptacle into which the pin must be inserted during normal operation.

To manually drive a pedestal axis, place the pedestal disable switch in the SAFE (down) position and remove the stow pin letting it hang by the restraining wire. Push the handcrank in and turn.

CAUTION

Do not push the handcrank in while the pedestal is running. The handcrank will engage the drive train and personal and/or equipment damage may result.

Removing a stow pin from the "operate" receptacle disables the electrical drive. Placing a stow pin in the "stow-position" receptacle mechanically locks the antenna axis in the stow position.

SECTION 4
DETAILED DESCRIPTION

The components and principles of operation of the pedestal and servo control system have been described briefly in the previous sections; in this section the various parts and circuits involved are discussed in greater technical detail. In following these discussions refer to the appropriate drawings and schematic diagrams.

4.1 Pedestal

4.1.1 Azimuth Section

The numbers in parentheses refer to parts shown on Fig. 7.1.

The azimuth housing and drive mechanism are designed around a 23-inch diameter 4-point-contact ball bearing with an integral internal gear of 18-inch pitch diameter (9). This combination bearing and gear is mounted in a machined seat in the upper end of the housing casting. A horizontal diaphragm, an integral part of the casting immediately beneath the bearing seat, provides the necessary radial rigidity for the large thin-section bearing and serves as an accurate mounting surface for the drive unit (13), synchro packages (as noted), and limit switches (18 and 22), all of which have gears meshing with the large internal gear.

The drive unit is a three-stage, precision, spur-gear reducer with a ratio of 111:1 between the motor pinion and the output pinion. The output pinion mates with the internal gear at a ratio of 7.58:1, resulting in an over-all ratio of 840:1 between the motor and the turntable. The gear train is lubricated by immersion in oil in the sealed, vented gearbox. Those low-speed shaft bearings which are above the oil level are permanently lubricated and sealed. A spring-applied, magnetically released brake is keyed directly to an extension of the first-stage compound gear shaft. A hand-drive assembly (16) is located on the outside surface of the azimuth housing (refer to Fig. 7.2). The shaft of the drive assembly operates a set of spring-disengaged bevel gears which drive the azimuth motion of the pedestal through the gearing in the gearbox. A stow-pin receptacle (15) and a stow fitting (14) are located to the right of the handcrank.

Refer to Fig. 7.3. The stow-pin receptacle is designed to function as an automatic brake release and electrical interlock. When the stow pin is present in the receptacle, the pedestal will function normally. When the stow pin is withdrawn, as in preparation for manual operation of the pedestal, the drive-train brake is mechanically released and the pedestal drive circuit is broken.

A three-inch pitch diameter antibacklash gear in mesh with the main drive or turntable gear drives the shafts of the two synchro assemblies. The Model PX1-X28 Synchro Assembly has two 23CT6 synchros geared 1:1 with the output.

Synchro and limit-switch drive gears and the drive-unit brake are all accessible from above, through the elevation-housing access opening, for adjustment and removal. The drive-unit gearbox, servomotor, limit switches, and synchros are all accessible and removable through the two large doors (9 and 15) in the azimuth housing.

4.1.2 Elevation Section

The numbers in parentheses refer to parts shown on Fig. 7.4.

The elevation section utilizes the same drive unit (assembly of motor, gearbox, and brake) that is used in the azimuth section. The main elevation drive gear is an 18-inch pitch diameter spur gear mounted on an 8-inch diameter tubular steel horizontal shaft (2) which is rigidly supported by two 9-inch diameter thin-section ball bearings (20) in opposite ends of the cast aluminum housing. The drive unit is installed on a boss at one end of the housing so that the output pinion meshes with the large spur gear. This arrangement places the servomotor horizontally in one access opening while the brake is conveniently located inside a cover (12) at one end of the housing. The brake access cover also serves as a housing for the manual drive shaft bearing and the stow-pin receptacle.

Refer to Fig. 7.5. The stow-pin receptacle is designed to function as an automatic brake release and electrical interlock. When the stow pin is present in the receptacle, the pedestal will function normally. When the stow pin is withdrawn, as in preparation for manual operation of the pedestal, the drive-train brake is mechanically released and the pedestal drive circuit is broken.

Two independent limit switches (11) are mounted at the end of the housing opposite the drive unit, one to limit travel in each direction of motion. A torsion-bar type resilient stop (13) is provided to arrest elevation motion and protect mounted antennas in the event of limit-switch malfunction. The stop strikers (22) are installed near the rim of the large drive gear and strike the actuating arm of the torsion bar at the established limit of travel. The fixed end of the bar is anchored to the opposite wall of the housing.

A three-inch pitch diameter antibacklash gear in mesh with the main drive or turntable gear drives the shafts of the two synchro assemblies (10). The Model PX1-X28 Synchro Assembly has two 23CT6 synchros geared 1:1 with the output.

4.2 Servo Control System

4.2.1 Servo Control Unit

The component designation numbers referred to in this paragraph are for the elevation channel. The azimuth channel is identical and in each case an analogous reference can be made. The Servo Control Unit schematic is shown in Fig. 7.9

The Model 3611-J77 Servo Control Unit contains a demodulator subchassis, and a dc amplifier subchassis. Mode-selection and rate-input controls, and the limit and sector indication lights are located on the front panel of this unit.

4.2.1.1 Switching Circuits: Fig. 4.1 is a simplified switching diagram showing power turn-on, mode selection, and operation of the stow lock and limit switches. The mode-selection switches shown in Fig. 4.1 are for the elevation channel; the azimuth channel has an identical set.

The system is turned on by depressing the POWER pushbutton. This switch completes the circuit for the coil of the magnetic contactor located in the power control box. When this circuit is completed the contactor closes and all the system power is supplied through the contactor, with the exception of the ac voltage applied to the "enable" circuit which will be described below.

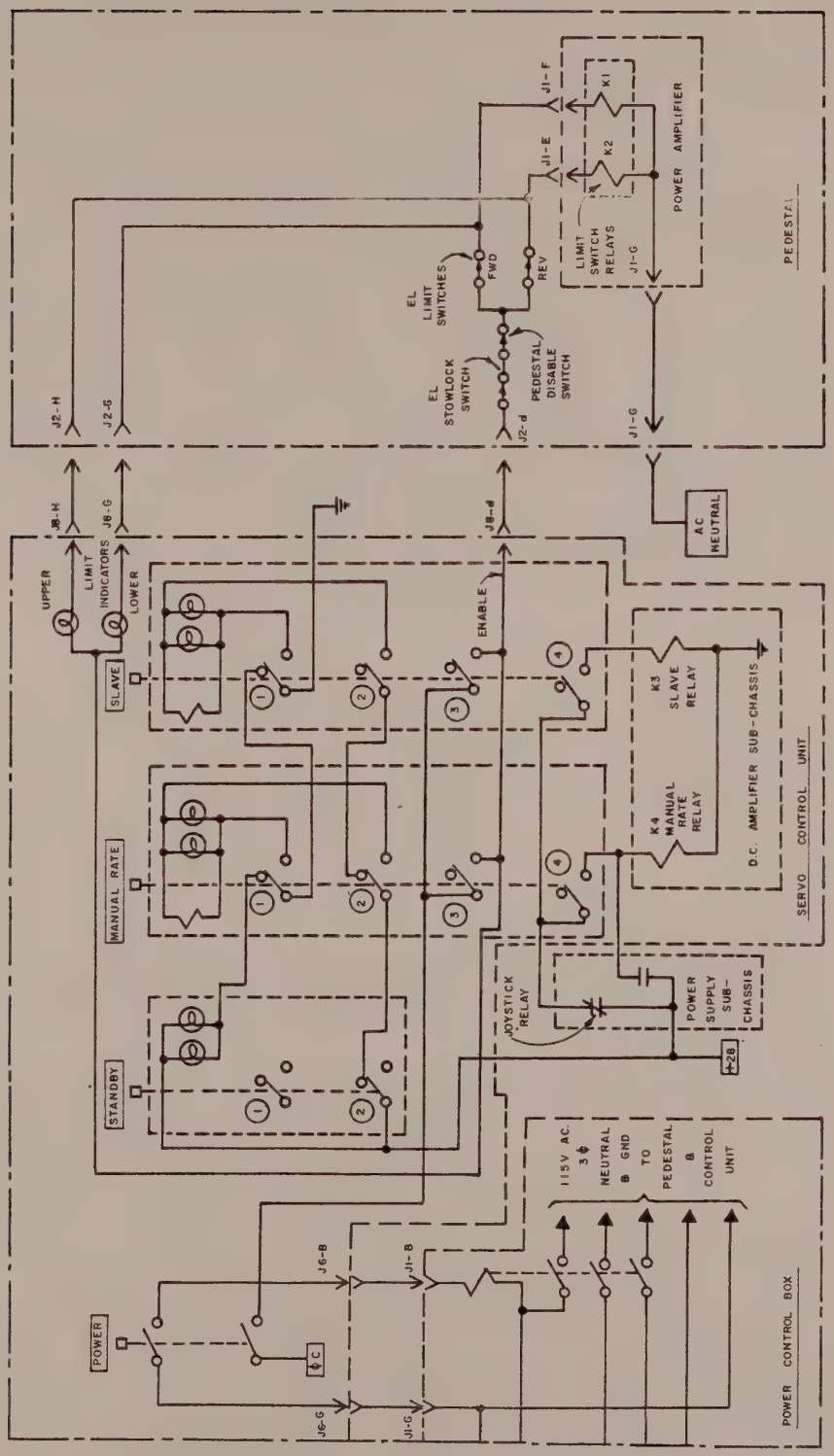


Fig. 4.1. Power Distribution and Control Circuits, Simplified Diagram

Poles 1 and 2 of the MANUAL RATE selector (A5) and the SLAVE selector (A4) and pole 2 of the STANDBY selector (A6) are connected in an interlock circuit such that actuation of any one of the selectors releases any other selector which might have been previously engaged. This circuit functions as follows. When power is initially applied to the system; all of the contacts of the mode-selector switches are in the position shown. The positive side of a 28-volt dc supply is connected to the normally closed contacts of pole 2 of the STANDBY selector. Assume that with the mode-selector switches in the positions shown, the MANUAL RATE selector is actuated. The actuation moves the armatures of the switch sections to the position opposite to that which is drawn. Current from the 28-volt dc supply now flows through the normally closed contacts of pole 2 of the STANDBY switch, the normally open contacts of pole 2 of the MANUAL RATE selector, the holding coil of the MANUAL RATE selector, the normally open contacts of pole 1 of the MANUAL RATE selector, and the normally closed contacts of the SLAVE selector to ground thus energizing the MANUAL RATE holding coil and keeping the switch sections of the MANUAL RATE selector depressed.

When it is desired to change modes of operation, for example, to switch from MANUAL RATE to SLAVE, it is necessary only to depress the SLAVE selector button. The MANUAL RATE circuit is broken and the SLAVE circuit is energized in a manner similar to that described above.

The system is placed in standby by depressing the STANDBY selector which breaks the path to the plus side of the 28-volt dc supply so that either the MANUAL RATE or SLAVE selector will return to the released position.

Pole 3 of the MANUAL RATE and SLAVE selector switches are wired together to form an "or" circuit for control of relays in the pedestal-mounted power amplifiers. For the system to operate it is necessary that one or the other of these switches be actuated. The 115-volt ac "enable" voltage is supplied through a second pole of the POWER switch. With either the MANUAL RATE or the SLAVE mode selector actuated, the 115-volt signal is transmitted to the pedestal where it is applied through the stow-lock switch and the pedestal disable switch (which should be closed) to the forward and reverse limit switches. If neither limit switch is actuated, that is, if the pedestal is between its extremes of travel, both relays K1 and K2 in the power amplifier are energized. When energized, relays K1 and K2

allow the firing pulses from the servo amplifier to be applied to the SCR's in the power amplifier for the forward and reverse directions of rotation, respectively. With both STANDBY selectors depressed or if the stow pin is in the stow position, both K1 and K2 are de-energized and the pedestal will not rotate in either direction. If the forward limit switch is actuated, K1 is de-energized and K2 is energized. Under these conditions the pedestal will not rotate in the forward direction but will rotate in the reverse direction if the proper signal is applied.

Pole 4 of the MANUAL RATE and SLAVE switches control relays located on the dc amplifier subchassis. For example, selection of the manual rate mode causes relay K2 of the dc amplifier to be energized and K2 connects the manual rate signal into the dc amplifier and also connects in the appropriate servo-loop-compensation networks. The 28 volts dc which is used to operate the mode-selector relays in the dc amplifier subchassis is connected to the mode-selector switches through a pair of normally closed contacts of relay K1 located on the power supply subchassis. This relay is actuated by the pushbutton on an optional joystick accessory. Even if the joystick is not supplied as a part of the system, it is necessary that the joystick relay (K1) be plugged into its socket for the system to operate.

The forward and reverse limit indicators are connected from the ac "enable" line to the hot side of relay coils K1 and K2. Thus, when the relays are energized there is no difference of potential across the limit indicators and they are not illuminated. If the ac line is removed from the relay coil by actuation of the limit switch, by placing the stow pin in the stowed position, or by placing the pedestal disable switch in the SAFE position, current flows from the 115-volt supply through the appropriate neon indicator light and through the coil of the de-energized relay to neutral thus allowing the lamp to light. The impedance of the indicator light is much greater than that of the coil of relays K1 or K2 and the lamp-illumination current is not sufficient to energize the relay.

Sector indicators are provided to show the direction of the closest limit and avoid driving to the end of the pedestal travel while tracking. The two sector indicators are labeled CW and CCW Illumination of the CW sector light indicates that the pedestal has been rotated clockwise from a zero position.

4.2.1.2 Demodulator: The azimuth and the elevation demodulator circuits are identical. Each consists of an ac error amplifier, a full-wave sampling demodulator bridge, and a twin-tee filter.

The ac error amplifier consists of a differential input stage (transistors Q1, Q2, and associated components), followed by a common-emitter amplifier stage (transistor Q3 and associated components). The gain of the circuit depends upon the amount of feedback as determined by the setting of potentiometer R1. The circuit amplifies the synchro error signal connected to its input and applies it to the full-wave sampling demodulator bridge.

The operation of the demodulator is similar to that of a sampling switch. A reference signal, required for demodulator operation, is the 120-volt ac line which is coherent with the command synchro transmitter.

Assume initially that the error signal is of the same phase as the reference signal. As the reference signal starts positive, capacitor A1C6, which has been charged during the previous positive half-cycle, is discharging through A1R9. Bridge No. 2, consisting of A1CR7 through A1CR10, is thereby reverse-biased and cannot conduct. As the reference voltage approaches its peak, the voltage across A1C6 is less than the reference voltage; the bridge is forward-biased and can conduct. When current is flowing through the bridge, the junction of A1CR7 and A1CR9 is effectively connected to the junction of A1CR8 and A1CR10 and the peak error voltage appears across A1C8, charging it to that value.

As the reference voltage starts negative, capacitor A1C5, which has been charged during the previous negative half-cycle, is discharging through A1R8. Bridge No. 1 is thereby back-biased and is effectively open. As the reference approaches its negative peak, A1C5 begins charging and bridge No. 1 conducts. When the bridge conducts, the junction of A1CR3 and A1CR5 is effectively connected to the junction of A1CR4 and A1CR6 and the peak error voltage is placed across A1C7 charging it to that value.

The dc voltage appearing at the output is equal to the combined voltages on A1C7 and A1C8, or approximately twice the peak error signal.

If the phase error signal is reversed, action similar to that described above takes place, but charges of opposite polarities are placed on A1C7 and A1C8.

The full-wave sampling demodulator bridge compares the amplified synchro error signal from the amplifier to the reference signal and produces a bipolar dc voltage at its output whose polarity depends upon the phase of the input signal and whose magnitude depends upon the amplitude of the input signal.

The twin-tee filter at the output of the demodulator is used to eliminate unwanted ripple-frequency components.

4.2.1.3 DC Amplifier Subchassis: This unit contains circuits for both channels. Each channel comprises two solid-state, plug-in operational amplifiers, two mode-selector relays, and a plug-in circuit board containing the loop-compensation circuits. The operation of the dc amplifier subchassis is described here by specific modes of operation.

(a) Manual Rate Mode: In the manual rate mode a single operational amplifier, A5, is used. When this mode is selected, relay K4 is energized by the MANUAL RATE mode selector on the front panel. The manual rate input is applied to the subchassis through pin 6 of J8. It is transmitted through the normally open contacts (pins 11 and 7) of relay K4 to the input network labeled Z3. With relay K4 energized, network Z8 is connected as a feedback between output and input of amplifier A5 through relay contacts 5 and 9 of relay K4. A tachometer input, that is, a dc voltage proportional to the speed of rotation of the drive motor, is applied through pin 8 of J8 and contacts 12 and 8 of relay K4 to network Z6, such that the tachometer input is summed with the manual rate signal. Thus, the output of amplifier A5 is proportional to the difference between the manual rate input and the tachometer input. The output of amplifier A5 is applied to network Z10 which is a nonlinear circuit introduced to compensate for inherent nonlinearities in the silicon controlled rectifier drive system. (The referenced compensating networks are custom designed for each individual system at the time of check out for best system operation.)

(b) Slave Mode: The slave input signal is a dc signal (from the demodulator subchassis) whose magnitude is a function of the magnitude of the error and whose polarity indicates the direction of the error. In the slave mode relay K3 is energized and both operational amplifiers (A4 and A5) are utilized. The slave input signal is applied to the dc amplifier subchassis through pin 4 of J8. The signal is transmitted through the normally open contacts (pins 11 and 7) of K3 to network Z1 which is the input impedance to amplifier A4. Network Z2 is a feedback impedance which is connected between the output and input of A4. The output of A4 is applied through the normally open contacts (pins 10 and 6) of relay K3 to network Z4 which is the input impedance for operational amplifier A5. In the slave mode, contacts 5 and 9 of relay K3 connect

network Z9 as a feedback element between the output and input of amplifier A5. A tachometer input is summed into the summing junction of operational amplifier A5 through network Z7. In the slave mode also, network Z10 compensates for system nonlinearities.

4.2.2 Servo Amplifier

The Model 3620-J77 Servo Amplifier consists of four Scientific-Atlanta Model SCA-1 Servo Control Amplifiers--two for each channel--and associated circuitry. Each SCA-1 varies the firing angle of silicon controlled rectifiers (SCR's) in the power amplifier as a function of the dc error input voltage (see Fig. 7.14).

Two Model SCA-1 Servo Control Amplifiers are associated with each axis of the pedestal. Of these two, one controls the SCR's for the reference winding of the ac drive motor and one controls the SCR's for the control winding. Each SCA-1 produces pulses for both forward and reverse rotation of the drive motors (not simultaneously, except near zero input). The two outputs of the SCA-1 used to control the control winding are applied to different SCR's in the power amplifier such that pulses on the forward line produce a given phase at the control winding and pulses on the reverse line produce the opposite (180°) phase. The two outputs of the SCA-1 used to control the reference winding are applied to a diode "or" circuit (CR3 and CR4 for elevation) whose output is applied to a single set of SCR's; the phase of the signal applied to the reference winding does not vary.

A block diagram of one Model SCA-1 Servo Control Amplifier is shown in Fig. 4.2. Each channel accepts a bipolar dc input voltage and produces as an output a series of pulses which is applied to the gate electrode of the appropriate silicon controlled rectifiers (SCR's) in the power amplifier. The phase angle (with respect to the ac voltage applied to the SCR's) at which the first pulse in the series occurs is a function of the dc error input voltage.

Line voltage of the same phase as that applied to the SCR's in the power amplifier is applied to a crossover pulse generator. The crossover pulse generator generates a pulse each time the line voltage passes through zero, i.e., at a frequency of 120 cps. The 120-cps pulses are applied to a ramp generator which produces a positive- and a negative-going ramp at 120 cps in synchronism with the 120-cps pulses. The two ramps are applied to two comparators where

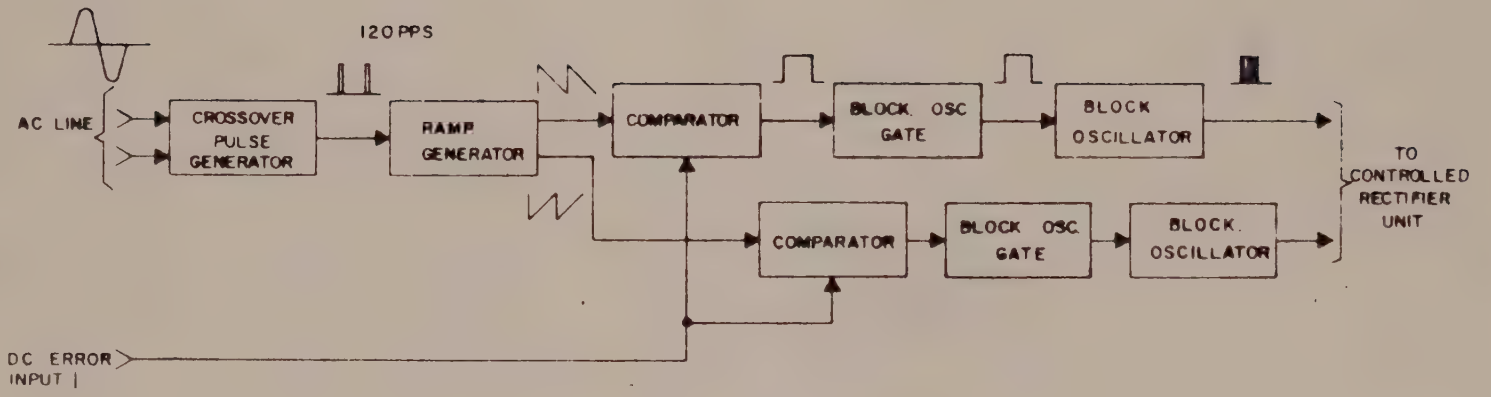


Fig. 4.2. Block Diagram of Model SCA-1 Servo Control Amplifier

the amplitudes of the ramps are compared to the amplitude of the dc input. The comparator whose ramp input has the same polarity as the dc input generates an output whenever the ramp voltage is exceeded by the dc input voltage. The comparator output triggers a blocking oscillator to free-run. The oscillator produces SCR firing pulses from the time that the ramp voltage equals the dc input voltage until the end of the ramp period. Generation of a series of pulses ensures that the SCR's will be fired each half cycle even though the SCR might be back-biased by the antenna-positioner drive-motor counter-emf at the time the two inputs to the comparator reach coincidence. Fig. 4.3 is a simplified timing diagram.

4.2.2.1 Crossover Pulse Generator: Transistors A1Q1, A1Q2, and associated circuitry function to produce a pulse at each crossover of the applied ac voltage. The ac voltage from the secondary of T1 is applied between the junction of A1R1 and A1R2, and the junction of the anode of A1CR2 and the cathode of A1CR4. During one-half cycle of the ac line voltage, transistor A1Q1 is forward-biased and base current flows as shown in Fig. 4.4(a). Collector current flows through A1R3 and pulls the collector of A1Q1 down from its positive supply voltage. At the end of the half-cycle (near crossover), the applied ac voltage is no longer of sufficient amplitude to cause base current to flow and the collector voltage rises toward +11 volts. After crossover (at the start of the next half-cycle), both A1Q1 and A1Q2 are forward-biased and base current flows as shown in Fig. 4.4(b). Collector current again flows through A1R3 and pulls down the collector of A1Q1. Thus, collector current flows through A1R3 at all times except during the period near the ac line-voltage crossover. Since a crossover occurs twice each cycle of the line voltage, 120-cps pulses are generated coincident with crossover.

4.2.2.2 Ramp Generator: Transistors A1Q3, A1Q4, A1Q5, A1Q6, and associated components are arranged in a modified Miller integrator circuit. When a crossover pulse is not present on the base of A1Q3, A1C2 charges through resistors A1R1, A1R9, and A1R11, its charging rate linearized by emitter follower A1Q7. Transistors A1Q5 and A1Q6 and resistors A1R7 and A1R10 are connected in series across the supply voltage. The current through this circuit is controlled by the charge of A1C2. The voltages on the collectors of A1Q5 and A1Q6 are of opposite polarity and, since A1R7 and A1R10 are the same value, of equal magnitude. Thus, during the interval between pulses, a positive-going ramp in generated at the collector of A1Q6 and a negative-going ramp at the collector of A1Q5. A

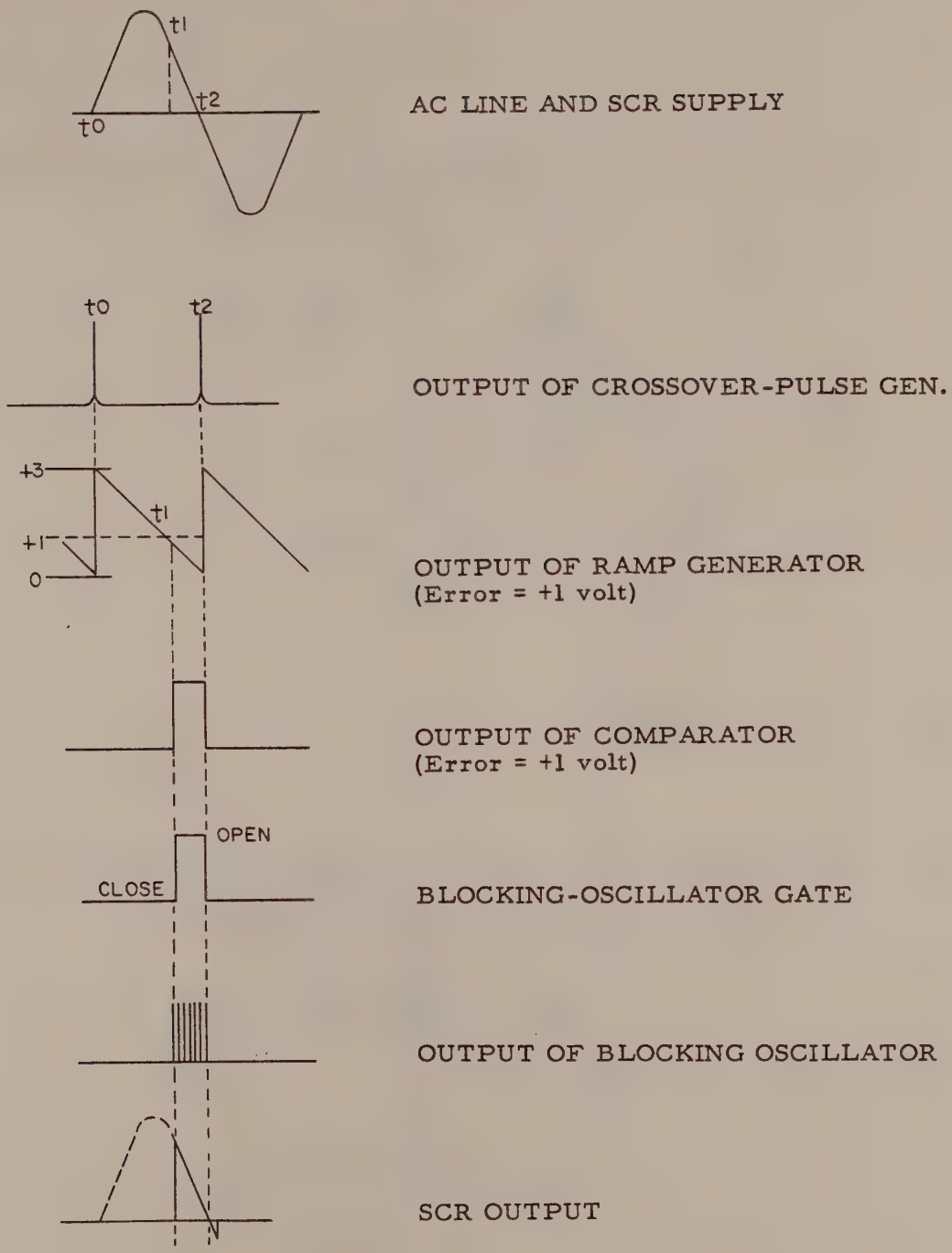


Fig. 4.3. Timing Diagram for Servo Control Amplifier

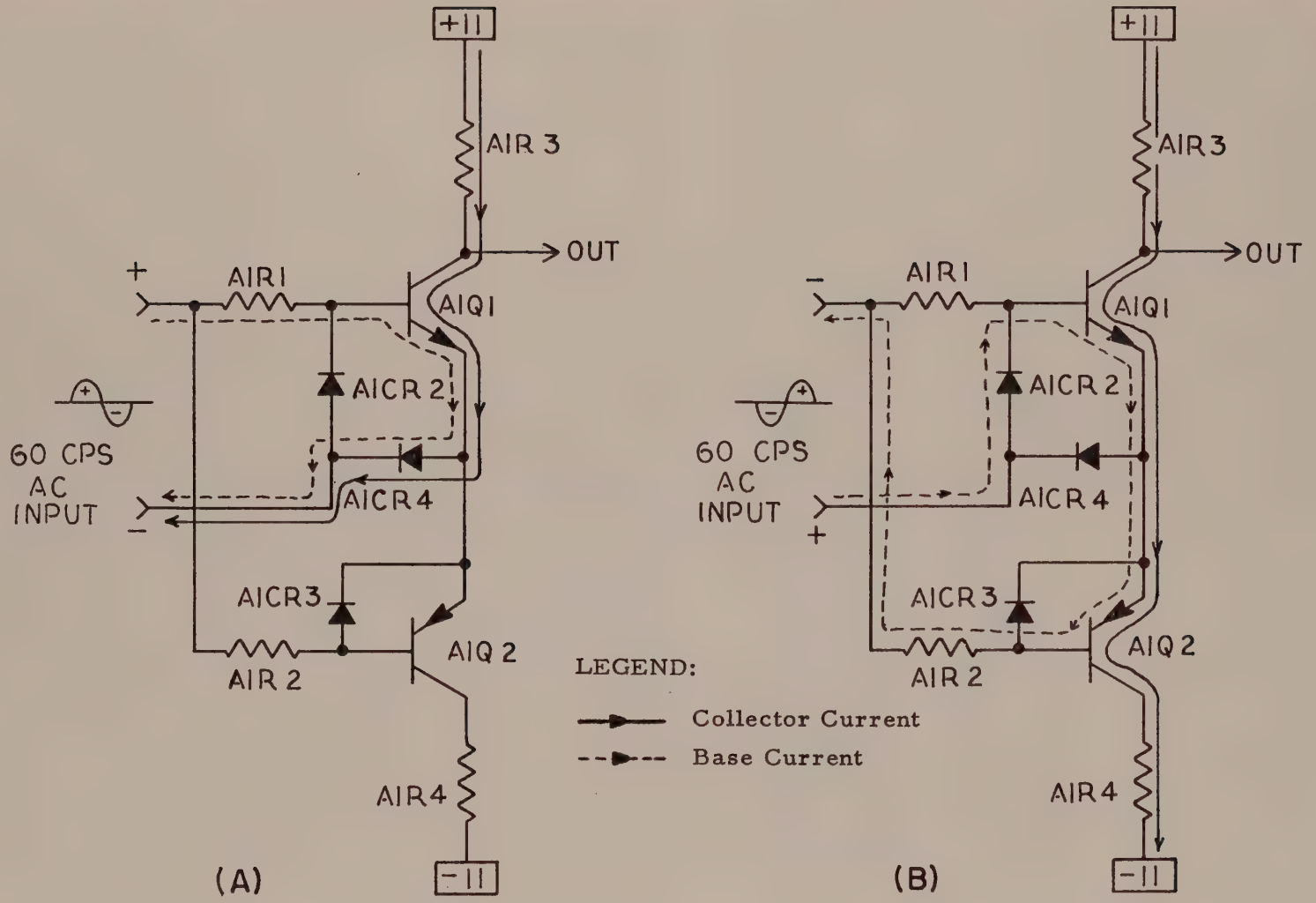


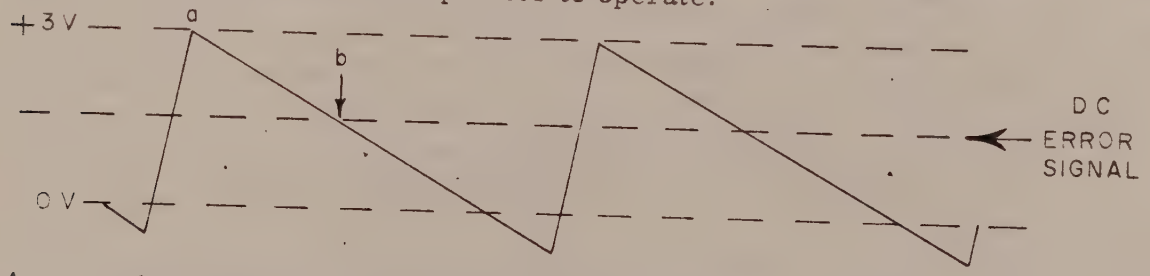
Fig. 4.4. Crossover Pulse Generator Simplified Diagram

pulse at the output of the crossover pulse generator (taken at the junction of A1R3 and A1R5) discharges capacitor A1C2 through transistor A1Q4. A positive pulse on the base of A1Q3 cuts off A1Q3 and forward-biases A1Q4 causing it to conduct. A low-impedance discharge path is thus completed for A1C2 and it discharges rapidly. After crossover, the pulse is removed and A1C2 begins charging again.

The two ramps are applied to a resistive network (resistors A1R13--A1R18 and potentiometers A1R2 and A1R3) which determines the amplitude (slope) and dc levels of the ramp. The setting of resistor A1R2 determines the amplitude (slope) of the ramps and A1R3 is used to adjust their dc levels.

4.2.2.3 Comparator Circuits: Each channel contains two comparator circuits--one for the reverse signal (positive-going ramp) and one for the forward signal (negative-going ramp). The comparators are identical except for complimentary transistors. Two inputs are provided to each comparator circuit--the ramp and the dc error voltage.

The negative-going ramp is applied to the base of A2Q1, and the dc error signal to the base of A2Q2. These transistors, together with A2Q5 and associated components, constitute the comparator which operates on the negative-going ramp. The waveform of the ramp is shown here. The dc error voltage applied to A2Q2 must be positive for this comparator to operate.



Assume that the ramp voltage is decreasing at time a. Collector current of A2Q1 flowing through A2R2 holds A2Q2 cut off. As the ramp voltage decreases, the bias on the base of A2Q2 decreases and A2Q2 will eventually become forward-biased (this occurs at time b when the ramp voltage is slightly less than the dc error voltage). When A2Q2 is forward-biased and conducts, the drop in collector voltage (taken across A2R1) is applied as forward bias to A2Q5 causing it to conduct. The output of the comparator, a positive gate taken across A2R6, is applied to the blocking oscillator gate A2Q7. Diodes A2CR1 and A2CR2 (SG-22's) provide approximately 1-volt reverse bias to the base-emitter junction of A2Q5 to hold A2Q5 cut off before A2Q2 conducts.

4.2.2.4 Blocking Oscillator Gate and Blocking Oscillator: Transistor A2Q7, diode A2CR5 (SG-22), and the secondary winding of A2T1 constitute the blocking oscillator gate. Before coincidence (A2Q5 cutoff), A2Q7 is reverse-biased and cut off by the forward voltage drop across A2CR5. The positive output gate from the comparator overcomes this bias and A2Q7 conducts. With A2Q7 conducting, pin 5 of A2T1 is effectively placed at ground potential thus providing a ground return for the secondary winding of A2T1 and enabling the regenerative blocking action of A2Q9 to occur. The blocking oscillator free-runs while the gate is open; pulses appearing across the tertiary winding of A2T1 (pins 1 and 3) are transmitted to the gate circuit of the appropriate SCR's in the power amplifier.

The comparator, blocking oscillator, and gate described above control the forward motion of the drive motors and function when the input error voltage is positive. The reverse direction (negative error voltage) is controlled by the circuitry comprising A2Q3, A2Q4, A2Q6, A2Q8, and A2Q10 which form another comparator, blocking oscillator and gate.

4.2.2.5 DC Power Supply Subchassis: The dc power supply subchassis contains three separate power supplies. Two of these are sealed modules supplying 15 volts at approximately 100 ma. which is used to supply the operational amplifiers on the dc amplifier subchassis and circuits on the demodulator subchassis. The two 15-volt supplies are wired so that one delivers a positive output with respect to ground and the other a negative output. The third power supply is an unregulated 28-volt dc supply which supplies the relay coils, lights for the mode selectors, the standby switch and the power switch. The input to all three supplies is 115v ac, 60 cps, single phase.

A 28-volt dc relay (K1) accomplishes the transfer between any mode in which the system may be and the joystick input whenever the joystick accessory pushbutton is actuated.

4.2.3 Power Amplifier

Two Model 3632 Power Amplifiers are utilized in this system--one for elevation and one for azimuth. Since both are identical, only the elevation unit is described here.

The unit is completely solid state and provides bidirectional proportional control of a two-phase, 400-watt ac servomotor. Both motor windings are controlled by the power amplifier; however, only one winding is reversible. In addition to the circuits for motor control, the power amplifier also contains a power supply and relay circuit for controlling brakes which are mechanically linked to the motor shaft. The unit contains externally controlled relays which allow the amplifier to be disabled by limit-switch actuation or stow-lock engagement.

Fig. 7.15 is the schematic diagram of the power amplifier. Referring to this drawing, the bridge arrangement of SCR's and diodes located near the center of the drawing is for control of the motor control winding, that is, the winding which is reversible in phase. The components in the upper-right and the lower-left legs of this bridge control the forward direction of rotation. The components in the upper-left and lower-right legs of the bridge control the reverse direction of rotation. The SCR and diode network consisting of CR5 through CR8, which is located in the upper-center portion of the drawing, control the reference (non-reversible) winding of the motor. The three circuits at the left of the drawing consisting of transistors Q1 through Q6 and associated components are gating circuits synchronized with the ac supply for each of the windings. Their purpose is to gate through to the SCR's the firing pulses only during the half cycles of the line voltage during which the SCR should conduct. This prevents possible short-circuiting of the bridge by SCR's firing from extraneous gating signals.

When the servo system calls for rotation in the forward direction, pulses from the servo amplifier unit are applied to the power amplifier through pins R and W of connector J1. For rotation in the reverse direction, pulses are applied through pins S and T of J1. These pulses are for control of the SCR's supplying power to the control winding of the motor. Triggers are applied to the reference-winding circuitry through pins N and P of J1 for forward and reverse rotation. The input firing signal, which is described in more detail in paragraph 4.2.2, consists of a train of pulses with the train occurring at a 120-cycle repetition rate. The number of pulses in the train is determined by the power called for by the servo system in responding to its input signal. The train of pulses is synchronized with the line voltage which supplies the SCR's controlled by the firing pulses.

The operation of an SCR is similar to that of a gas-filled thyratron. When the SCR is forward-biased, that is, when its anode is at a positive potential with respect to its cathode, it will normally not conduct unless its gate electrode is made positive with respect to the cathode. Once the SCR has been brought into conduction, conduction continues regardless of the signal on the gate electrode until the SCR becomes reverse biased. It is a function of the firing pulses to turn the SCR on at the appropriate time. Normally only the first pulse in the pulse train is effective since, if it turns the SCR on, the SCR is insensitive to the voltage on the gate electrode. However, the train of pulses is generated to ensure that the SCR is fired at every half cycle, even though it might be back-biased at the moment the first firing pulse occurs by back emf from the motor. The time of occurrence of the first pulse in the pulse train relative to the line voltage determines the power output from the SCR's. For example, if this first pulse occurs at a time when the SCR is forward biased but is only, say, 10° from crossover of the line voltage, a small amount of power will be delivered since the SCR will be cut off at crossover. If, however, the first pulse occurs near the peak of the applied line voltage, the SCR will be allowed to conduct for approximately 90° and a larger quantity of power will be delivered by the SCR's. Obviously, the largest amount of power which can be delivered occurs when the first pulse of the pulse train occurs at the start of a given half cycle which allows the SCR to conduct for the full half cycle.

As was previously mentioned, the function of the gating circuits is to allow the firing pulses to be applied to the SCR's only during the portion of the applied line voltage when the SCR is forward biased. The operation of the circuit will be described using the gating circuit consisting of Q3 and Q4 and associated components as a reference. Assume that a pulse train is being applied between pins R and W of connector J1 at a 120-cycle repetition rate. The voltage applied to the primary of transformer T8 is in phase with the pulse train but at half the repetition rate, that is, 60 cycles. During each half cycle of the line voltage applied to the primary of transformer T8, the secondary of T8 forward biases either transistor Q3 or Q4. For example, during one half cycle the secondary current flows through R7, CR11, the emitter-to-base connection Q4, resistor R8, and T8 primary, thus forward biasing Q4. During the other half cycle, transistor Q3 is forward biased. For the first case, where Q4 was forward biased, the input pulses then flow through the emitter-to-collector connection of Q4, through CR13, through the primary of T2, and back to the return side of

the trigger source. During the half cycle in which Q3 is forward biased, the triggers flow through the emitter-to-collector connection of Q3, diode CR10, through the primary of T1, and back to the trigger source. Operation of the other two gating circuits is identical. The phasing of transformer T8 is such that the pulses are applied to the primary of transformer T1 when the upper corner of the bridge is positive with respect to the lower corner. Under these conditions, current flows from the upper corner of the bridge through diode CR28 through SCR CR32 (during the time it is triggered on), through R26, and thence to pin C of connector J2 which is connected to one side of the control winding of the motor. The return current is through the winding, pin B of J2, diode CR37, SCR CR41, and back to the other side of the ac line. During the next half cycle of the ac line, the lower corner of the bridge is positive and pulses are applied to transformer T2. Current then flows through diode CR42, SCR CR36, pin B of J2, the motor winding, pin C of J2, R26, diode CR33, SCR CR26, and back to the other side of the ac line. Thus, an ac current flows through the motor winding whose magnitude is determined by the period of time the SCR's are allowed to conduct. If the firing triggers are applied to pins S and T of J1, the gating circuit consisting of Q5 and Q6 allows the pulses to be applied to the primary of transformers T3 and T4 on alternate half cycles. Under these circumstances, the current flow is through the other two legs of the bridge, which results in an ac signal of the opposite polarity being applied to the control winding. The reference winding which is connected to the power amplifier through pins A and E of connector J2, is supplied with an ac signal of fixed phase but varying amplitude. The motor turns in the forward direction when pulses are applied to transformers T1 and T2 and turns in the reverse direction when pulses are applied to transformers T3 and T4.

An inductor, L1, is placed in series with the SCR-diode bridge for current limiting and for phase correction. Fuses F1 and F2, which are in the lines supplying the control and reference windings, limit the current to approximately that required for the stall-torque rating of the motor.

The circuit consisting of diodes CR19 through CR22 is a full-wave bridge rectifier for control of an electromechanical brake which is mechanically connected to the motor shaft. The power to the brake is applied through a relay network consisting of contacts on relays K1, K2, K3, and K4. Diodes CR18 and CR48 are arc-suppressor diodes for eliminating any transients

which may damage the bridge rectifier. The brakes employed in this system are the fail-safe type, that is, they require power to be held off. With no power applied, the brakes are on and the motor shaft is held. Relay K5, which is also powered from the brake supply, removes the SCR firing pulses from the reference winding when the brakes are applied.

Relays K1 and K2 are, respectively, the forward and reverse limit relays. These relays are energized except when the pedestal has reached one of its travel limits. For purposes of description, assume that the pedestal is rotating in the forward direction, that is, pulses are being applied to transformers T1 and T2. If the pedestal is allowed to rotate continuously, it will eventually actuate the forward limit switch. Actuation of this limit switch removes the power from relay K1 causing it to de-energize. De-energizing K1 causes the pulses to be removed from transformers T1 and T2 by the contacts of relay K1 associated with the trigger input (pins R and W of J1). Simultaneously, power is removed from the brake by the contact of K1 in the brake circuit so that the brake now engages bringing the pedestal to a halt. Note that at this time relays K3 and K4 are de-energized. It is now impossible to drive the pedestal further in the forward direction. It is possible, however, to drive the pedestal in the reverse direction. If pulses are applied through pins S and T of connector J1, transformers T3 and T4 receive the pulses and fire the SCR's in the upper-left and lower-right legs of the bridge allowing current to flow through them. Note that even though current is flowing through these two legs of the bridge, the brake is still applied and the motor cannot move. However, as the current is increased through the two legs of the bridge, a voltage drop is developed across resistor R25 and the coil of relay K4 which is in parallel with it (when relay K1 is de-energized). When the voltage drop across R25 is of sufficient magnitude to allow relay K4 to pull in, its normally open contacts (pins 1 and 3) shunt the open contacts of relay K1 (pins 1 and 3) allowing power to be applied to the brake circuit, thereby releasing the brake and allowing the pedestal to rotate in the reverse direction. When the pedestal has moved far enough in the reverse direction to allow the forward limit switch to close, K1 is re-energized and K4 is de-energized. The operation at the other extreme of travel, that is, in the reverse direction, is identical, relays K2 and K3 being involved. In this system the external circuits controlling relays K1 and K2 are arranged such that, if the system is put into standby or if a stow lock is engaged, both relays K1 and K2 are de-energized and therefore the pedestal cannot rotate in either direction.

Since some radio-frequency noise is generated by turning the SCR's on, the SCR's are enclosed in a shielded chamber of the power amplifier. The ac lines entering this portion of the power amplifier pass through RFI filters to suppress any radiation from the lines. All other circuits which enter the chamber pass through feedthrough capacitors for RFI suppression. The motor leads connecting the motor to the power amplifier are enclosed in a completely shielded cable with the shield bonded to the connector at each end.

SECTION 5
MAINTENANCE AND ADJUSTMENTS

5.1 Pedestal

5.1.1 Lubrication

5.1.1.1 Gearboxes: The gearboxes should be filled with an aircraft gear oil per specification MIL-L-7808D. Seasonal or periodic oil changes are not necessary if this type of oil is used, and it is necessary only to maintain the oil at the level of the "FILL" plug.

CAUTION

Do not mix oils in the gearbox. Oil must be kept off the brake assembly which is attached to the gearbox housing.

5.1.1.2 Azimuth Drive Gear and Bearing: The internal gear and bearing were packed at assembly with an extreme-pressure grease (Shell Alvania EP2 or equivalent). The bearing should require no further lubrication as long as the pedestal remains assembled. Grease may be added to the internal gear as necessary to maintain a thin film on the teeth of the gear and pinion. Since an extreme-pressure grease is applied initially, additional lubricant will be required only at infrequent intervals depending on operation. To lubricate the gear, remove one elevation housing access cover and the azimuth turntable cover plate. Apply grease to the gear teeth with a brush or paddle.

5.1.1.3 Elevation Drive Gear and Bearings: The shaft bearings and main drive gear were lubricated at assembly with an extreme-pressure grease (Shell Alvania EP2 or equivalent). The shaft bearings should require no further lubrication as long as the pedestal remains assembled. Grease may be added to the main drive gear and pinion as necessary to maintain a thin grease film on the gear teeth. However, since an extreme-pressure grease is applied initially, additional lubricant will be required only at great intervals depending on frequency of operation. To lubricate the gear, remove the elevation housing access cover and apply grease to the gear teeth with a brush or paddle.

5.1.1.4 Elevation Limit Stop: The torsion-bar stop utilizes a single spherical bearing and two cam-follower bearings which serve as strikers. These bearings require no lubrication.

5.1.2 Maintenance and Adjustments

5.1.2.1 Gearboxes: The numbers in parentheses refer to parts shown on Fig. 7.6.

The precision gearing and oversize bearings should enable the reducer to operate for life with no attention other than lubrication. In the event of oil leakage past either of the two shaft seals (2 and 24), those seals may be replaced easily by removing either the motor or brake to gain access to the seal.

Removal of the gearbox from the pedestal is accomplished, after removal of the motor, by removing the four cap screws which hold the gearbox flange to the pedestal. A tapped hole is provided in each flange so that back-off screws may be used if necessary to force the assembly free of the locating pins.

CAUTION

Prior to removal of a gearbox from either azimuth or elevation, first disconnect the brake actuator link from the brake. Refer to Fig. 7.3 for azimuth and Fig. 7.5 for elevation.

5.1.2.2 Brakes: The Simplatrol brake is a simple reliable mechanism which requires no maintenance except for infrequent adjustment of the end cap to compensate for lining wear. This adjustment may be accomplished without removal of the brake, since the brake end cap is accessible through convenient openings in both the azimuth and elevation installations.

To adjust the brake for lining wear, remove the three screws near the bottom of the end cap, index the cap 60° clockwise to the next screw holes, and replace the screws. A brake-assembly drawing is located at the rear of this manual. If the armature drags after adjustment, running clearance may be restored by loosening

the setscrews in the armature hub and positioning the armature axially to a position which will permit free rotation. Tighten setscrews.

The entire brake assembly may be removed from the gearbox by first loosening the two setscrews which fasten the brake armature to the gear shaft and then removing the two screws at the base of the brake housing. The brake assembly may then be pulled off the gear shaft through the access hole in the casting.

CAUTION

Before removing the brake access cover on the elevation housing, be sure to disconnect the brake actuator link and the brake electrical wiring. Avoid pulling excessively on the wires connected to the limit switch which is attached to the cover.

After replacing the brake assembly, the armature must be positioned axially on the gear shaft as described above to run freely when the release coil is energized.

5.1.2.3 Limit Switches: The elevation limit switches are actuated by two rings secured to the elevation drive torque tube. To adjust the switches, loosen the setscrews in the rings, rotate them to the desired limit point, and tighten the screws. Make sure that the new limit point is located before the mechanical stops are reached.

The azimuth primary limit-switch unit contains the forward and reverse limit switches and an azimuth sector switch (refer to Fig. 7.8). The adjustment of the limit switches is described in the General Electric publication which follows this section. The azimuth secondary limit-switch is described in the General Electric publication.

The azimuth sector switch has been set at the factory to actuate at the midpoint of the azimuth travel sector. To adjust the sector switch, rotate the azimuth section of the pedestal to the position at which a change of state of the switch is desired. Remove the cover from the limit-switch package. Loosen the two cam-locking screws and rotate the stainless steel cam by hand as desired. Be

careful not to disturb the two phenolic limit-switch cams. Tighten the cam-locking screws. Loosen the two switch-plate mounting screws and move the switch so that it clicks just before the top of the cam rise.

CAUTION

Make sure that the lobe of the limit-switch cam directly below the sector cam will clear the sector-switch mounting plate.

5.1.2.4 Synchros: The synchros in each transmitter package have been electrically zeroed together at the factory with the azimuth section at the travel-sector midpoint and with the elevation turntables in their zero position (see paragraphs 2.2 and 2.3).

The synchro transmitters can be adjusted by removing the transmitter package cover, loosening the hold-down buttons securing the synchros, and rotating the synchro bodies as required. A recommended synchro-zeroing procedure is given following this section.

5.2 Servo Control System

5.2.1 Demodulator Adjustments

The adjustments described below have been made at the factory and normally will not need to be made except as required due to normal component aging or replacement of parts.

5.2.1.1 AC Amplifier Gain Adjustment: Potentiometer R5 is the modulator gain adjustment. A clockwise rotation reduces gain, a counterclockwise rotation increases gain. This potentiometer is factory set at approximately 1/3 the rotation between minimum gain and maximum gain. If readjustment is necessary it should be made under dynamic conditions, that is, the system should be in the slave mode and the gain adjustment made in small increments while noting the effect on the servo system operation. In general, increasing the gain will give faster response and less system stability while lowering the gain will give slower response and better stability.

5.2.1.2 Notch Network Adjustment: Potentiometer R6 adjusts the notch frequency of the notch network. With the system in the slave mode, allow the pedestal to null to the position commanded by the slave input. Connect an oscilloscope between the junction of capacitor A1C12 and resistor A1R21 and ground. Adjust R6 for minimum ripple on the dc voltage at this point.

5.2.2 Servo Amplifier Adjustments

Adjustments described in these paragraphs have been made initially at the factory for proper operation. Readjustment should be required only to correct for normal component aging and when parts replacement is required. The servo amplifier contains two channels; the adjustments are identical for each channel. Only the azimuth-channel adjustments are described.

5.2.2.1 Preliminary Procedure: Operate the POWER switch of the Servo Control Unit to apply ac voltage to the servo amplifier and select the MANUAL RATE mode. Place the "Disable" switch on the pedestal in the "Disable" position.

For the two following adjustments, set the AZIMUTH MANUAL RATE CONTROL on the Servo Control Unit for zero volts between the base of transistor A2Q2 in the servo control amplifier and chassis ground.

5.2.2.2 Initial Firing Angle Adjustment: Adjust R1 so that one or two firing pulses appear across the tertiary windings (pins 1 and 2) of transformers A2T1 and A2T2.

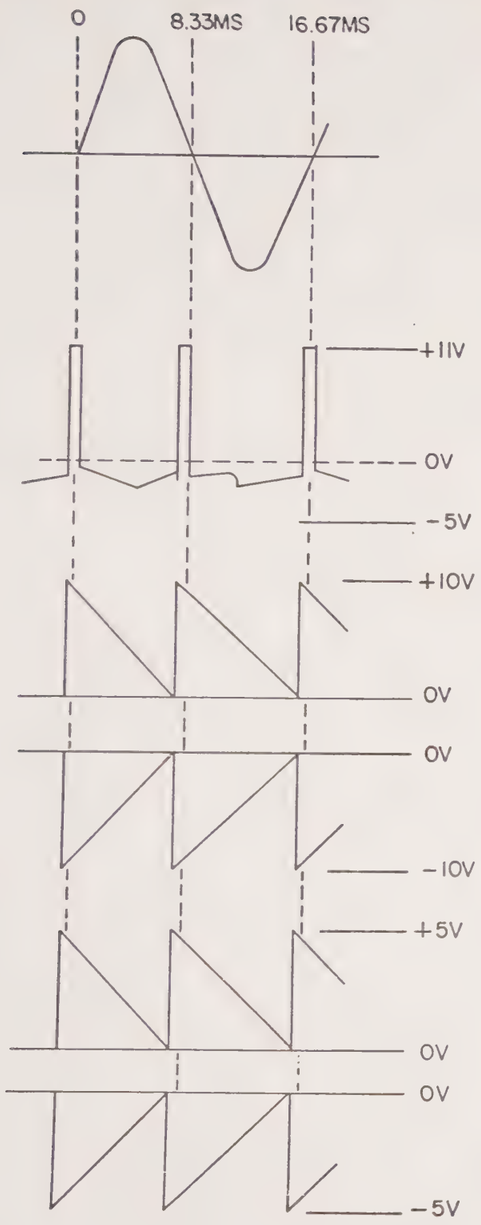
5.2.2.3 Forward-Reverse Balance Adjustment: Adjust R3 to obtain an equal number of pulses at the tertiary windings (pins 1 and 2) of A2T1 and A2T2 as obtained above. If more than two pulses appear, readjust R1 (initial firing angle adjustment) as described above.

5.2.2.4 Gain Adjustments: Set the AZIMUTH MANUAL RATE CONTROL of the Servo Control Unit for +4 volts at the base of A2Q2 of the azimuth servo control amplifier. Adjust R2 for a continuous series of pulses at the tertiary winding (pins 1 and 2) of A2T1.

5.2.3 Waveforms

The waveforms in Fig. 5.1 were obtained with zero dc error signal input and zero drive-motor armature current.

The waveforms were taken with a Tektronix Model 545 Oscilloscope. Set the Y-axis input for dc signals and synchronize the internal sweep with the ac line. Unless otherwise specified, waveforms are measured between the indicated point and chassis ground. A variation of ±10% from the indicated voltage value may be tolerated.



SECONDARY OF T1
(40v peak-to-peak)

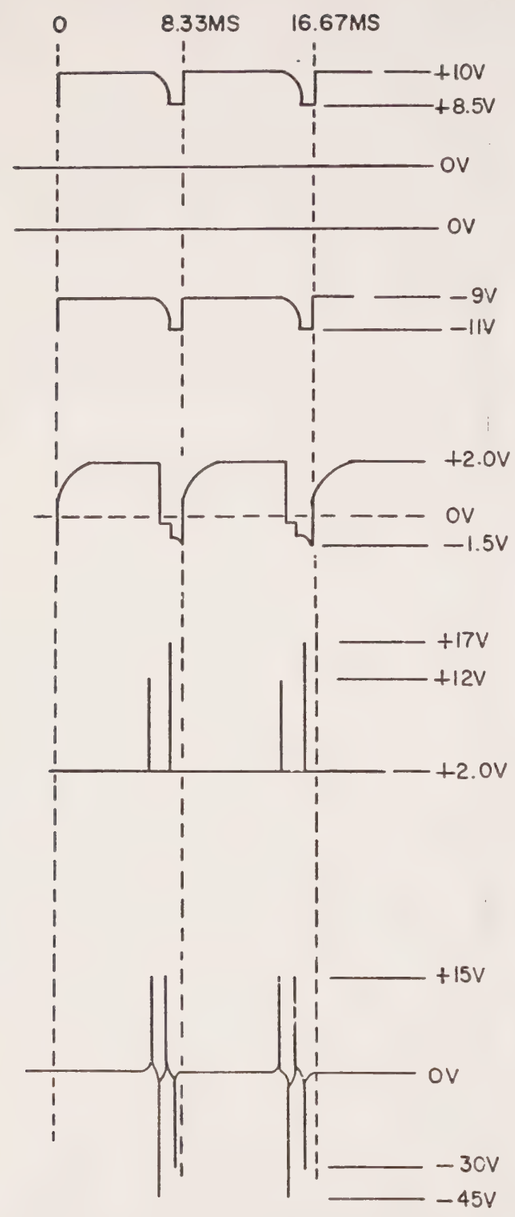
A1Q1 COLLECTOR

A1Q5 COLLECTOR

A1Q6 COLLECTOR

A2Q1 BASE

A2Q3 BASE



A2Q5 BASE
(E_{in} = 0v)

A2Q6 BASE
(E_{in}=0v)

A2Q7 COLLECTOR
(E_{in} = 0v)

A2Q9 BASE
(E_{in} = 0v)

PIN 3 TO PIN 4 OF A2T1

Fig. 5.1. Servo Control Amplifier Waveforms

SYNCHRO ELECTRICAL ZERO

The electrical zero of a synchro is defined as that position of the rotor with respect to the stator at which a minimum fundamental voltage is induced in the secondary circuit, and where this secondary voltage is in phase with the primary voltage.

There are two null positions for any synchro. The correct null can be found by connecting the synchro to a voltage source and voltmeter as shown in Figure 1, then determining coarse zero by turning the rotor.* As the rotor is turned, one null point near the correct electrical zero will be found. To determine the fine electrical zero, connect the synchro as shown in Figure 2 and adjust the rotor slightly until a null is established. This is the exact electrical zero.

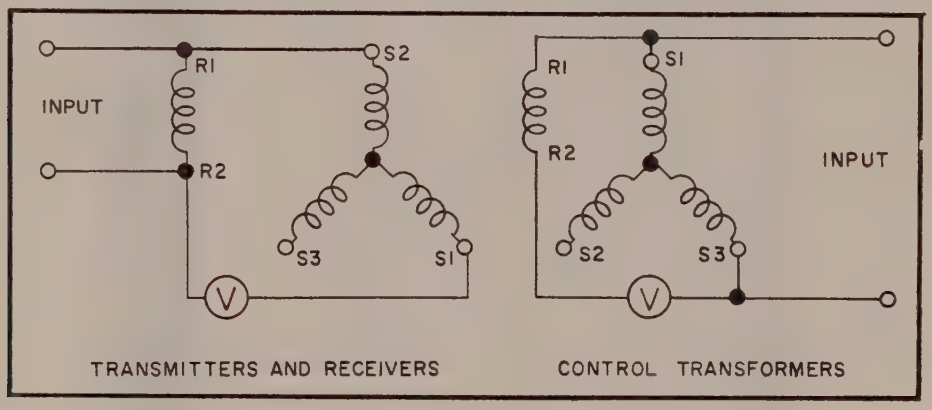


FIGURE 1
COARSE ZERO

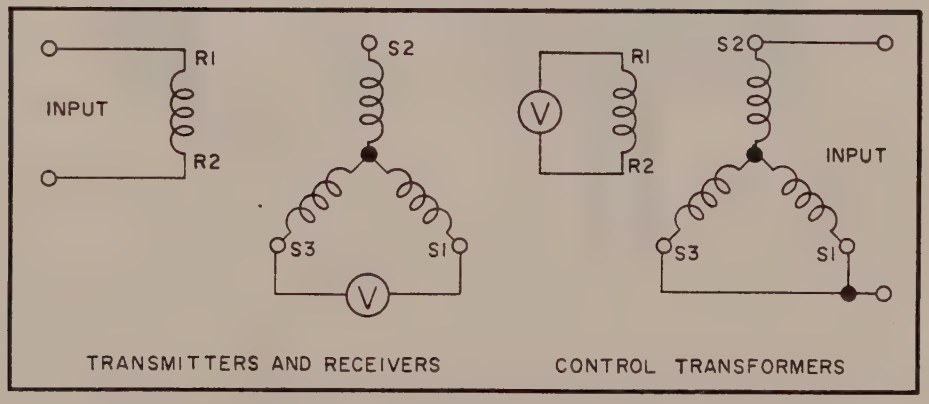


FIGURE 2
FINE ZERO

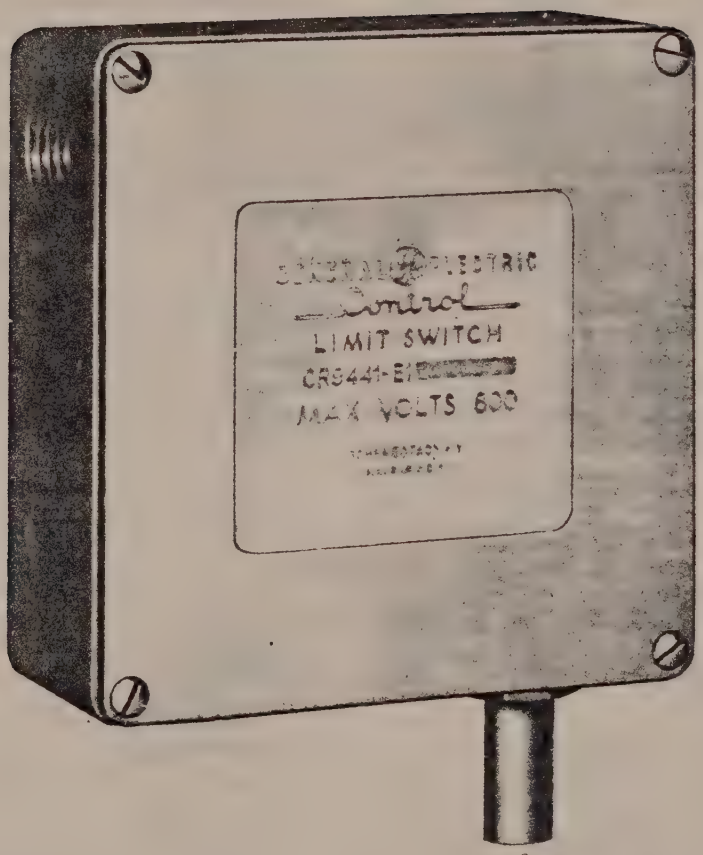
*Effective rotor rotation can be achieved by loosening the synchro mounting clamps and turning the synchro housing.

INSTRUCTIONS

GEH-1734A
Supersedes GEH-1734

CR9441-E

ROTATING LIMIT SWITCH



GENERAL ELECTRIC

CR9441-E
ROTATING LIMIT SWITCH

The CR9441-E rotating-type limit switches are designed to co-ordinate reversing operations with the number of revolutions of a motor shaft or the rotation of driven equipment. Typical applications include control of limits of travel on machinery, opening and closing of doors and windows, and operation of valves on machine tools. The internal construction features shown in Fig. 1 are the same for all forms of this switch. The die-cast, general-purpose enclosure pictured in Fig. 1 and 4 is used with the E1 and E4 forms. Refer to outline, Fig. 5, for details of enclosures for watertight forms E2 and E5, and explosion-proof forms E3 and E6.

DESCRIPTION

The operating mechanism consists of cams A and B, carried on cam support E, and driven by shaft O through gears C and D.

Cams A and B operate the contacts of the two switch units F and G by depressing plungers J. Cam rider H separates cam and plunger to prevent binding. Limit switch forms E1, E2, and E3 have snap-action switch units with contact sequence as shown in Fig. 2. Slow-make-and-break switch units as used with forms E4, E5, and E6 have the contact sequence of Fig. 3.

Interruption ratings differ for the two types of switch units. As noted in Table I, d-c ratings apply only to forms E1, E2 and E3, having snap-action units, as slow-make-and-break units used with forms E4, E5, and E6 are not recommended for d-c duty. A-c ratings are the same for all forms, except that two-circuit ratings do not apply to switch units having provision for only a single circuit.

TABLE I

Switch Unit D-c Interruption Ratings, CR9441-E1, -E2, -E3 Only

		125 v	250 v	600 v
Single-circuit	Inductive Amp	0.50	0.25	0.14
	Noninductive Amp	1.00	0.40	0.23
Two-circuit	Inductive Amp	0.30	0.15	0.07
	Noninductive Amp	0.60	0.30	0.18

TABLE II

Switch Unit A-c Interruption Ratings

		115 v ~	230 v ~	600 v ~
Single-circuit	Inductive Amp	25	25	7.5
	Noninductive Amp	25	25	7.5
Two-circuit	Inductive Amp	25	25	3.0
	Noninductive Amp	25	25	3.0

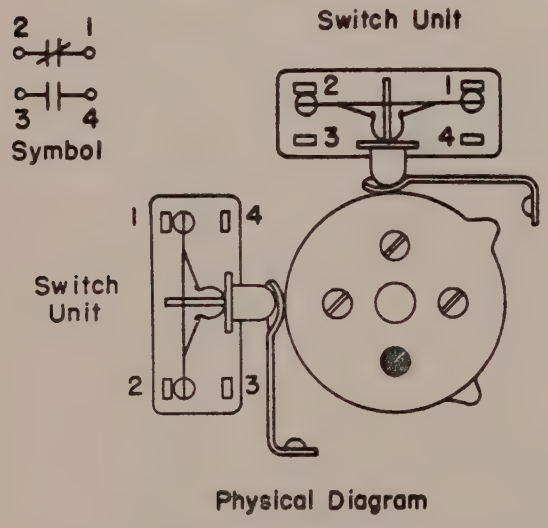


Fig. 2. Contact sequence of CR9441-E1, -E2, -E3 limit switches

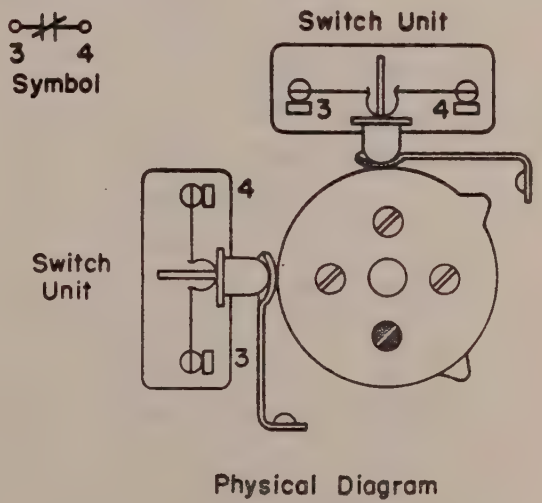


Fig. 3. Contact sequence of CR9441-E4, -E5, -E6 limit switches

SECTION 6
REPLACEABLE PARTS LISTS

Assembly drawings of the pedestal and some of its major components are located in Section 7; a bill of materials is included as a part of each drawing.

When ordering parts from Scientific-Atlanta, Inc. be sure to include the equipment model number, serial number, and a description of the part.

MANUFACTURERS' CODE LETTERS

Code	Manufacturer
A	Aerovox
ABE	Amphenol-Borg
ALP	Allied Automotive Parts
ASC	Automatic Switch
BC	Barber-Coleman
BF	Bendix Aviation (Friez Div.)
BG	Boston Gear Works
BUS	Bussman
CLM	Carr Lane
CRL	Centralab
CM	Cinch
CLS	Clarostat
CP	Climax Metal Products
CD	Cornell-Dubilier
CRH	Crouse-Hinds
DP	Dale Products
DM	Diehl
DR	Drake Manufacturing
ES	Elastic Stop Nut
FB	Fafnir
FS	Federal Screw Products
GA	Garlock
GE	General Electric
HC	Hoffman Electronics

MANUFACTURERS' CODE LETTERS - Continued

Code	Manufacturer
IRC	International Resistance
JM	Johns-Manville
J	E. F. Johnson
K	Kaydon
L	Littelfuse
LIN	Lincoln Engineering
MMC	McGill
MET	Methode Electronics
MS	Micro Switch
M	J. W. Miller
MH	Minneapolis-Honeywell
MOT	Motorola
ND	New Departure
O	Ohmite (LD = Little Devil)
PER	Permatex
PR	Philbrick
PIC	PIC Design
PB	Potter & Brumfield
RCA	Radio Corporation of America
RM	Rotron
T	Sarkes Tarzian
SA	Scientific-Atlanta
STL	Simplatrol Products
SP	Sprague
SPB	Split Ballbearing
STT	L. S. Starrett
ST	Sterling
STL	Simplatrol Products
SC	Switchcraft
SY	Sylvania Electronics
TPI	Technipower
TI	Texas Instruments
TE	Transitron Electronics
TT	Triad

MANUFACTURERS' CODE LETTERS - Continued

Code	Manufacturer
USC	United States Semiconductor Products
VM	Victor Manufacturing & Gasket
VSM	Voi-Shan Manufacturing
WK	Waldes-Kohinoor
WIL	J. H. Williams

PARTS LIST
POWER CONTROL BOX

Component Designation	Description	Mfr.*	Mfr. Part No.
F1 F2 F3	Fuse, 20 amp, dual element	BUS	FRN-20
J1	Connector, receptacle, female, 8 contacts	ABE	MS3102A-18-8S
J2	Connector, receptacle, female, 7 contacts	ABE	MS3102A-24-10S
K1	Contactor, power, 2 pole, single throw	CH	9560H1
TB1	Terminal strip, barrier type, 5 terminals	CM	150-5
XF1	Fuse block, double pole, 30-60 amp	CH	10982H3A-2
XF2	Fuse block, single pole, 30-60 amp	CH	10982H2A-2

*See "MANUFACTURERS CODE LETTERS."

PARTS LIST
MODEL 3611 SERVO CONTROL UNIT

The component designations are abbreviated. Prefix each component with the number shown below.

1A1

Component Designation	Description	Mfr.*	Mfr. Part No.
A1	Subassembly, dc amplifier	SA	31603
A2	Subassembly, demodulator	SA	31604
A1P7 A1P8 A2P3 A2P4	Connector, receptacle, female, 14 contacts	ABE	57-40140
DS1 thru DS6	Indicator assembly, neon glow	DR	R118
F1	Fuse, 3 amp, slow blow	L	313003
J1	Connector, receptacle, male, 21 pins	ABE	MS3102A-28-12P(Y)
J2	Connector, receptacle, male, 21 pins	ABE	MS3102A-28-12P
J3	Connector, receptacle, female, 37 contacts	ABE	MS3102A-28-21S
J4	Unassigned		
J5	Connector, receptacle, male, 17 pins	ABE	MS3102A-20-29P

*See "MANUFACTURERS' CODE LETTERS."

The component designations are abbreviated. Prefix each component with the number shown below.

1A1

Component Designation	Description	Mfr.*	Mfr. Part No.
J6	Unassigned		
J7	Connector, receptacle, female, 19 contacts	ABE	MS3102A-22-14S
J8	Connector, receptacle, male, 8 pins	ABE	MS3102A-18-8P
R1 R2	Resistor, variable, wirewound, 10,000 ohms ±5%, linearity 0.25%, tapped at 50% rotation	CLS	Series-42-900
R3 R4	Resistor, fixed, composition, 56,000 ohms ±10%, 1/2w	O	LD
R5 R6	Resistor, fixed, composition, 12,000 ohms ±10%, 1/2w	O	LD
S1 S2	Switch assembly, 4PDT, momentary push type, consists of:		
S5 S6	Operator-indicator unit with holding coil	MS	2C32
	Barrier mount, black plastic	MS	2B4
	Front panel, clear plastic	MS	2A70
	4PDT Switch assembly	MS	2D9
	Lamp, 28v	GE	327

*See "MANUFACTURERS' CODE LETTERS."

The component designations are abbreviated. Prefix each component with the number shown below.

1A1

Component Designation	Description	Mfr.*	Mfr. Part No.
S3 S7	Switch assembly, DPDT, momentary push type, consists of:		
	Operator-indicator unit	MS	2C7
	Barrier mount, black plastic	MS	2B4
	Front panel, clear plastic	MS	2A70
	DPDT Switch assembly	MS	2D2
	Lamp, 28v .	GE	327
S4	Switch assembly, DPDT, alternate-action, push type, consists of:		
	Operator-indicator unit	MS	2C7
	Barrier mount, black plastic	MS	2B4
	Front Panel, clear plastic	MS	2A70
	2PDT Switch assembly	MS	2D26
	Lamp, 28v	GE	327
S5 S6	See S1		
S7	See S3		
XF1	Fuse holder, panel mounting	BUS	HKP

*See "MANUFACTURERS' CODE LETTERS."

PARTS LIST

MODEL 3611-J77 SERVO CONTROL UNIT

SUBUNIT: DC AMPLIFIER

The component designations are abbreviated. Prefix each component with the number shown below.

1A1A1

Component Designation	Description	Mfr.*	Mfr. Part No.
A1 A2 A4 A5	Amplifier, operational	PR	P-65
A3 A6	Subassembly, plug-in card	SA	
A4 A5	See A1		
A6	See A3		
J1 J2 J4 J5	Connector, receptacle, female	MET	SD-610S
J3 J6	Connector, receptacle, female, 22 contacts	ABE	143-022-01
J4 J5	See J1		
J6	See J3		
J7 J8	Connector, receptacle, female, 14 contacts	ABE	57-40140
K1 thru K4	Relay, 4PDT, 24v dc coil	PB	KHP17D11

*See "MANUFACTURERS' CODE LETTERS."

PARTS LIST

MODEL 3611-J77 SERVO CONTROL UNIT

SUBUNIT: DC AMPLIFIER-continued

The component designations are abbreviated. Prefix each component with the number shown below.

1A1A1

Component Designation	Description	Mfr.*	Mfr. Part No.
XK1 thru XK4	Socket, solder terminal, with retaining ring	PB	9KH1

*See "MANUFACTURERS' CODE LETTERS."

PARTS LIST

MODEL 3611-J77 SERVO CONTROL UNIT

SUBUNIT: DC AMPLIFIER, PLUG-IN CARD

The component designations are abbreviated. Prefix each component with the number shown below.

1A1A1A3 (Azimuth)
1A1A1A6 (Elevation)

Component Designation	Description	Mfr.*	Mfr. Part No.
C1 C4	Capacitor, fixed, metallized paper, 1.0 μf, 200v	A	P8292ZN
C2 C5 C6	Capacitor, fixed, Mylar, 0.0047 μf, 400v	CD	WMF 4047
C3	Capacitor, fixed, metallized paper, 0.25 μf, 200v	A	P8292ZN
C4	See C1		
C5 C6	See C2		
CR1 thru CR4 CR9 thru CR12	Diode, silicon	TE	1N816
CR5 CR6	Diode, Zener, double anode	HC	RT6
CR7 CR8	Diode, Zener	TI	1N707
CR9 thru CR12	See CR1		

*See "MANUFACTURERS' CODE LETTERS."

PARTS LIST

MODEL 3611-J77 SERVO CONTROL UNIT

SUBUNIT: DC AMPLIFIER, PLUG-IN CARD-continued

The component designations are abbreviated. Prefix each component with the number shown below.

1A1A1A3 (Azimuth)
1A1A1A6 (Elevation)

Component Designation	Description	Mfr.*	Mfr. Part No.
R1 R2	Resistor, fixed, composition, 100 ohms ±10%, 1/2w	O	LD
R3	Resistor, fixed, composition, 68,000 ohms ±10%, 1/2w	O	LD
R4 R8	Resistor, fixed, composition, 22,000 ohms ±10%, 1/2w	O	LD
R5 R15	Resistor, fixed, composition, 10,000 ohms ±10%, 1/2w	O	LD
R6	Resistor, fixed, composition, 180,000 ohms ±10%, 1/2w	O	LD
R7	Resistor, fixed, composition, 33,000 ohms ±10%, 1/2w	O	LD
R8	See R4		
R9 R11	Resistor, fixed, composition, 47,000 ohms ±10%, 1/2w	O	LD
R10 R12	Resistor, variable, composition 50,000 ohms ±10%	IRC	201-00
R11	See R9		
R12	See R10		
R13 R14	Resistor, fixed, composition, 100,000 ohms ±10%, 1/2w	O	LD
R15	See R5		
R16	Resistor, fixed, composition, 3900 ohms ±10%, 1/2w	O	LD
R17	Resistor, fixed, composition, 12,000 ohms ±10%, 1/2w	O	LD

*See "MANUFACTURERS' CODE LETTERS."

PARTS LIST

MODEL 3611-J77 SERVO CONTROL UNIT

SUBUNIT: DEMODULATOR

The component designations are abbreviated. Prefix each component with the number shown below.

1A1A2

Component Designation	Description	Mfr.*	Mfr. Part No.
A1 A2	Subassembly, plug-in card	SA	
J1 J2	Connector, receptacle, female, 22 contacts	ABE	143-022-01
J3 J4	Connector, receptacle, female, 14 contacts	ABE	57-40140
R1 R3 R5 thru R8	Resistor, variable, composition, 10,000 ohms ±10%, 2w	O	CLU-1031
R2 R4	Resistor, variable, composition, 25,000 ohms ±10%, 2w	O	CLU-2531
R3	See R1		
R4	See R2		
R5 thru R8	See R1		
T1 T4	Transformer, filament, 115v pri. 40-ct, 20-ct, 10v sec @ 0.3 amp.	TT	F-90X

*See "MANUFACTURERS' CODE LETTERS."

PARTS LIST

MODEL 3611-J77 SERVO CONTROL UNIT

SUBUNIT: DEMODULATOR-continued

The component designations are abbreviated. Prefix each component with the number shown below.

1A1A2

Component Designation	Description	Mfr.*	Mfr. Part No.
T2 T5	Transformer, power, 115v pri., 115, 6v sec	TT	R-54X
T3 T6	Transformer, isolation, 230v CT to 115v ac	TT	N-68X
T4	See T1		
T5	See T2		
T6	See T3		

*See "MANUFACTURERS' CODE LETTERS."

PARTS LIST

MODEL 3611-J77 SERVO CONTROL UNIT

SUBUNIT: DEMODULATOR, PLUG-IN CARD

The component designations are abbreviated. Prefix each component with the number shown below.

1A1A2A1 (Elevation)
1A1A2A2 (Azimuth)

Component Designation	Description	Mfr.*	Mfr. Part No.
C1 thru C4	Capacitor, fixed, electrolytic, 25 μf, 25v	A	PWE-25-025
C5	Capacitor, fixed, paper, 0.01 μf, 200v	CD	WMF-2S1
C6	Capacitor, fixed, electrolytic, 100 μf, 25v	CD	NLW-100-25
C7 thru C10	Capacitor, fixed, metallized paper, 2 μf, 200v	A	P8292ZN
C11 C12	Capacitor, fixed, paper, 0.05 μf, 200v	A	P8292ZN
C13	Capacitor, fixed, paper, 0.1 μf, 200v	A	P8292ZN
CR1 CR2	Diode, Zener	HC	1N720
CR3 CR4	Diode, Zener	HC	1N702
CR5 CR7	Diode, Zener, double anode	HC	RT-6
CR6	Diode, Zener	HC	RS-6
CR7	See CR5		

*See "MANUFACTURERS' CODE LETTERS."

PARTS LIST

MODEL 3611-J77 SERVO CONTROL UNIT

SUBUNIT: DEMODULATOR, PLUG-IN CARD-continued

The component designations are abbreviated. Prefix each component with the number shown below.

1A1A2A1 (Elevation)
1A1A2A2 (Azimuth)

Component Designation	Description	Mfr.*	Mfr. Part No.
CR8 thru CR15	Diode, silicon	T	1N2484
P1 P2	Connector, printed circuit, male, 22 pins	ABE	133-022-03
Q1 thru Q4	Transistor	RCA	2N1605A
Q5	Transistor	RCA	2N1183
R1 R8 R10 R11	Resistor, fixed, composition, 10,000 ohms ±10%, 1/2w	O	LD
R2 R12	Resistor, fixed, composition, 5600 ohms ±10%, 1/2w	O	LD
R3	Resistor, fixed, composition, 270 ohms ±10%, 1/2w	O	LD
R4	Resistor, fixed, composition, 8200 ohms ±10%, 1/2w	O	LD

*See "MANUFACTURERS' CODE LETTERS."

PARTS LIST

MODEL 3611-J77 SERVO CONTROL UNIT

SUBUNIT: DEMODULATOR, PLUG-IN CARD-continued

The component designations are abbreviated. Prefix each component with the number shown below.

1A1A2A1 (Elevation)
1A1A2A2 (Azimuth)

Component Designation	Description	Mfr.*	Mfr. Part No.
R5	Resistor, fixed, composition, 2200 ohms ±10%, 1/2w	O	LD
R6	Resistor, fixed, composition, 220,000 ohms ±10%, 1/2w	O	LD
R7	Resistor, fixed, composition, 56,000 ohms ±10%, 1/2w	O	LD
R8	See R1		
R9 R18 R19	Resistor, fixed, composition, 150,000 ohms ±10%, 1/2w	O	LD
R10 R11	See R1		
R12	See R2		
R13 R14	Resistor, fixed, composition, 1000 ohms ±10%, 1/2w	O	LD
R15	Resistor, fixed, composition, 220 ohms ±10%, 1/2w	O	LD
R16 R17 R20 R21	Resistor, fixed, composition, 33,000 ohms ±10%, 1/2w	O	LD
R18 R19	See R9		
R20 R21	See R16		
R22	Resistor, fixed, composition, 6800 ohms ±10%, 1/2w	O	LD

*See "MANUFACTURERS' CODE LETTERS."

PARTS LIST

MODEL 3611-J77 SERVO CONTROL UNIT

SUBUNIT: DEMODULATOR, PLUG-IN CARD-continued

The component designations are abbreviated. Prefix each component with the number shown below.

1A1A2A1 (Elevation)
1A1A2A2 (Azimuth)

Component Designation	Description	Mfr.*	Mfr. Part No.
R23	Resistor, fixed, composition, 2700 ohms ±10%, 1/2w	O	LD
R24	Resistor, fixed, composition, 39,000 ohms ±10%, 1/2w	O	LD

*See "MANUFACTURERS' CODE LETTERS."

PARTS LIST

MODEL 3622 SERVO AMPLIFIER

The component designations are abbreviated. Prefix each component with the number shown below.

1A2

Component Designation	Description	Mfr.*	Mfr. Part No.
A1	Power supply	SA	31602
A2 thru A5	Servo control amplifier	SA	E-1497
A1P1 A1P2 A2P3 A3P3 A4P3 A5P3	Connector, cable, male, 14 pins	ABE	57-30140
F1 F2 F3	Fuse, 3 amperes, 3AG, slow blow	L	313003
J1	Connector, receptacle, male, 26 pins	ABE	MS3102A-28-12P
J2	Unassigned		
J3	Connector, receptacle, male, 37 pins	ABE	MS3102A-28-21P
J4	Connector, receptacle, female, 24 contacts	ABE	MS3102A-24-28S

*See "MANUFACTURERS' CODE LETTERS."

The component designations are abbreviated. Prefix each component with the number shown below.

1A2

Component Designation	Description	Mfr.*	Mfr. Part No.
J5	Connector, receptacle, female, 14 contacts	ABE	MS3102A-20-27S
J6	Connector, receptacle, female, 9 contacts	ABE	165-15
XF1 XF2 XF3	Fuse holder, panel mounting	BUS	HKP

*See "MANUFACTURERS' CODE LETTERS."

PARTS LIST

MODEL 3622 SERVO AMPLIFIER

SUBUNIT: POWER SUPPLY

The component designations are abbreviated. Prefix each component with the number shown below.

1A2A1

Component Designation	Description	Mfr.*	Mfr. Part No.
CR1 thru CR4	Diode, silicon	HC	1N2484
J1 J2	Connector, receptacle, female, 14 contacts	ABE	57-40140
K1	Relay, 4PDT, 24v dc coil	PB	KHP-17D11
PS1 PS2	Power supply, 14.5v dc, 0.1 amp	TPI	M-14.5-0.100AS
T1	Transformer, filament, 115v pri., 24, 27, 30, 33, 36v sec @ 3a	TT	F-61U
XK1	Socket, solder terminal, with retaining ring	PB	9KH1

*See "MANUFACTURERS' CODE LETTERS."

PARTS LIST

MODEL SCA-1

SERVO CONTROL AMPLIFIER

Component Designation	Description	Mfr.*	Mfr. Part No.
A1	Plug-in card		
A2	Plug-in card		
B1	Motor, synchronous, 115v ac	BC	DYAF 761-1
	(Fan blade)	BC	AYFA 502-1
C1 thru C4	Capacitor, fixed, electrolytic, 500 µf, 50v	CD	BR 500-50
CR1 CR2	Diode, silicon	GE	1N547
CR3 CR4	Diode, Zener, 10 watt	USC	1N1352A
J1	Connector, receptacle, female, 14 contacts	ABE	57-40140
J2	Connector, receptacle, female, 18 contacts	ABE	143-018-01
J3	Connector, receptacle, female, 22 contacts	ABE	143-022-01
R1	Resistor, variable, composition, 10,000 ohms ±10%, 1/2w	O	AS3607
R2	Resistor, variable, composition, 50,000 ohms ±10%, 1/2w	O	AS3609
R3	See R1		
RT1	Lamp, incandescent, 18v	GE	433

*See "MANUFACTURERS' CODE LETTERS."

PARTS LIST

MODEL SCA-1

SERVO CONTROL AMPLIFIER - Continued

Component Designation	Description	Mfr.*	Mfr. Part No.
T1	Transformer, filament, 115v pri., 12.6v, 1.5a sec.	TT	F-25X

PARTS LIST

MODEL SCA-1

SERVO CONTROL AMPLIFIER

SUBUNIT: PLUG-IN CARD

The component designations are abbreviated. Prefix each component with the number shown below.

A1

Component Designation	Description	Mfr.*	Mfr. Part No.
C1	Capacitor, fixed, tubular, paper, 0.01 µf, 200v	CD	WMFP123ZG
C2	Capacitor, fixed, metallized paper, 1 µf, 50v	A	P123ZN854
CR1	Diode, Zener, 6v	HC	RS-6
CR2 thru CR4	Diode, "Stabistor," 6v	TE	1N816 (SG-22)
J1	Connector, plug, male, 18 pins	ABE	133-018-03
Q1, Q5	Transistor	RCA	2N1605
Q2, Q3, Q6	Transistor	SY	2N404
Q3	See Q2		
Q4, Q7	Transistor	RCA	2N1183
Q5	See Q1		
Q6	See Q2		
Q7	See Q4		
R1 R2	Resistor, fixed, composition, 5600 ohms ±10%, 1/2w	O	LD

*See "MANUFACTURERS' CODE LETTERS."

PARTS LIST
MODEL SCA-1
SERVO CONTROL AMPLIFIER
SUBUNIT: PLUG-IN CARD - Continued

The component designations are abbreviated. Prefix each component with the number shown below.

A1

Component Designation	Description	Mfr.*	Mfr. Part No.
R3			
R4	Resistor, fixed, composition, 1500 ohms ±10%, 1/2w	O	LD
R5			
R15			
R17	Resistor, fixed, composition, 4700 ohms ±10%, 1/2w	O	LD
R18			
R6			
R7	Resistor, fixed, composition, 1000 ohms ±10%, 1/2w	O	LD
R10			
R8	Resistor, fixed, composition, 10 ohms ±10%, 1/2w	O	LD
R9			
R10	Resistor, fixed, composition, 6800 ohms ±10%, 1/2w	O	LD
R11	See R6		
R12	Resistor, fixed, composition, 1500 ohms ±10%, 1w	O	LD
R13			
R14	Resistor, fixed, composition, 8200 ohms ±10%, 1/2w	O	LD
R16			
R15	Resistor, fixed, composition, 33,000 ohms ±10%, 1/2w	O	LD
R16	See R5		
R17	See R14	O	LD
R18	See R5		

*MANUFACTURERS' CODE LETTERS."

PARTS LIST

MODEL SCA-1

SERVO CONTROL AMPLIFIER

SUBUNIT: PLUG-IN CARD

The component designations are abbreviated. Prefix each component with the number shown below.

A2

Component Designation	Description	Mfr.*	Mfr. Part No.
C1 C2	Capacitor, fixed, electrolytic, 25 µf, 25v	A	PWE25025
C3 C4	Capacitor, fixed, paper, 0.1 µf, 200v	A	P8292ZN
CR1 thru CR6	Diode, "Stabistor," 6v	TE	1N816 (SG-22)
CR7 CR8	Diode, silicon	GE	1N547
J1	Connector, receptacle, female, 22 pins	ABE	133-022-03
Q1 Q2 Q6 Q7 Q8	Transistor	RCA	2N1605
Q3 Q4 Q5	Transistor	SY	2N404
Q6 Q7 Q8	See Q1		
Q9 Q10	Transistor	RCA	2N1183A

*SEE MANUFACTURERS' CODE LETTERS."

PARTS LIST

MODEL SCA-1

SERVO CONTROL AMPLIFIER

SUBUNIT: PLUG-IN CARD - continued

The component designations are abbreviated. Prefix each component with the number shown below.

A2

Component Designation	Description	Mfr.*	Mfr. Part No.
R1 R3	Resistor, fixed, composition, 3300 ohms ±10%, 1/2w	O	LD
R2 R4 R10 R14	Resistor, fixed, composition, 5600 ohms ±10%, 1/2w	O	LD
R	See R1		
R	See R2		
R5	Resistor, fixed, composition, 1500 ohms ±10%, 1/2w	O	LD
R6	Resistor, fixed, composition, 10,000 ohms ±10%, 1/2w	O	LD
R7	Resistor, fixed, composition, 1200 ohms ±10%, 1/2w	O	LD
R8	Resistor, fixed, composition, 2200 ohms ±10%, 1/2w	O	LD
R9 R13	Resistor, fixed, composition, 39,000 ohms ±10%, 1/2w	O	LD
R10	See R2		
R11 R15	Resistor, fixed, composition, 4700 ohms ±10%, 1/2w	O	LD
R12 R16	Resistor, fixed, composition, 100 ohms ±10%, 1/2w	O	LD
R13	See R9		
R14	See R2		
R15	See R11		
R16	See R12		
R17 P1	Resistor, fixed, composition, 470 ohms ±10%, 1/2w	O	LD

*See "MANUFACTURERS' CODE LETTERS."

PARTS LIST

MODEL SCA-1

SERVO CONTROL AMPLIFIER

SUBUNIT: PLUG-IN CARD - Continued

The component designations are abbreviated. Prefix each component with the number shown below.

A2

Component Designation	Description	Mfr.*	Mfr. Part No.
T1 T2	Transformer, pulse, 1:1:1, 200v, 1w, 1200v-μsec	SP	31Z382

*See "MANUFACTURERS' CODE LETTERS."

PARTS LIST
MODEL 3711 POSITION INDICATOR

The component designations are abbreviated. Prefix each component with the number shown below.

1A3

Component Designation	Description	Mfr.*	Mfr. Part No.
A1 A2	Elevation or Azimuth Indicator	SA	IU-4
F1	Fuse, 3 amperes, 3AG	L	312003
J1	Connector, receptacle, male, 24 pins	ABE	MS3102A-24-28P
XF1	Fuse holder, panel mounting	BUS	HKP

*See "MANUFACTURERS' CODE LETTERS."

PARTS LIST

MODEL 3102-J77 PEDESTAL

SUBUNIT: AZIMUTH UNIT

The component designations are abbreviated. Prefix each component with the number shown below.

2A1

Component Designation	Description	Mfr.*	Mfr. Part No.
A1 A2	Power amplifier	SA	3632-J77
B1	Motor, servo, 2 phase, 2 pole, 90v, 60 cps	DM	ZP105-2281-2
B2	Fan, 115v, 60 cps, 3400 RPM, 1 phase	DM	FBE-42-26-1
B3	Synchro, transmitter	BA	23TR6
B4	Synchro, control transformer	BA	23CT6
B5	Tachometer, dc, 6.5v per 1000 RPM	DM	FDE7-15-1
C1	Capacitor, 3 μf, 330v ac	CD	CRX3030
C2 C3	Capacitor, feedthrough, 1500 μμf	CRL	CFC-1
J1	Connector, receptacle, female, 26 contacts	ABE	MS3102E-28-12S(Y)
J2	Connector, receptacle, female, 26 contacts	ABE	MS3102E-28-12S(X)

*See "MANUFACTURERS' CODE LETTERS."

PARTS LIST

MODEL 3102-J77 PEDESTAL

SUBUNIT: AZIMUTH UNIT-continued

The component designations are abbreviated. Prefix each component with the number shown below.

2A1

Component Designation	Description	Mfr.*	Mfr. Part No.
J3	Connector, receptacle, female, 26 contacts	ABE	MS3102E-28-12S
J4	Connector, receptacle, male, 7 pins	ABE	MS3102E-24-10P
J5	Connector, receptacle, female, 3 contacts	ABE	7-8648
J6	Connector, receptacle, female, 3 contacts	MA	JJ-033
	(Jack cover, waterproof)	SC	512
J7	Connector, receptacle, male, 5 pins	ABE	MS3102A-18-11P
P1 P2	Connector, cable, female, 22 contacts	ABE	MS3106A-28-11S
S1 S2 S7	Switch, SPDT, 5 amp	MS	MS25085-
S3	Switch, SPDT	MS	V3-601
S4 S5	Limit switch assembly	GE	CR9441-E-1F
S6	Switch, toggle, DPST	MS	MS35059-22

*See "MANUFACTURERS' CODE LETTERS."

PARTS LIST

MODEL 3102-J77 PEDESTAL

SUBUNIT: AZIMUTH UNIT-continued

The component designations are abbreviated. Prefix each component with the number shown below.

2A1

Component Designation	Description	Mfr.*	Mfr. Part No.
S7	See S1		
TB1 thru TB6 TB9	Terminal strip, barrier type 14 terminals	CM	140-14
TB7	Terminal strip, barrier type, 16 terminals	CM	140-16
TB8	Terminal strip, barrier type, 5 terminals	CM	150-5
TB9	See TB1		
TB10	Terminal strip, barrier type, 2 terminals	CM	140-2
W1	Cable, shielded, 5 conductor	SA	E2382
W2	Cable, shielded, 5 conductor	SA	E2383

*See "MANUFACTURERS' CODE LETTERS."

PARTS LIST

MODEL 3632

POWER AMPLIFIER

Component Designation	Description	Mfr.*	Mfr. Part No.
B1	Blower, ventilating, 115v ac	RM	A1A1
C1 thru C3	Capacitor, fixed, paper, 1 µf, 200v	A	P8292ZN13
C4	Capacitor, fixed, paper, bathtub, 0.1 µf, 1000v	CD	CP53B1FG104K
C5 thru C14	Capacitor, fixed, ceramic, feedthrough, 1500 µµf	A	CFC-1
CR1 thru CR4 CR9 thru CR17 CR19 thru CR24 CR29 CR34 CR35 CR40 CR43 CR46 CR47	Diode, silicon	HC	F-6 (1N2484)
CR5 CR6 CR27 CR28 CR31 CR33 CR37 CR38 CR42 CR44	Diode, silicon	MOT	1N3212

*See "MANUFACTURERS' CODE LETTERS."

PARTS LIST

MODEL 3632

POWER AMPLIFIER - Continued

Component Designation	Description	Mfr.*	Mfr. Part No.
CR7 CR8 CR25 CR26 CR30 CR32 CR36 CR39 CR41 CR45	Rectifier, silicon, controlled	GE	2N687
CR9 thru CR17	See CR1		
CR18 CR48	Diode, surge protector	GE	ERSZ1SA-7D7
CR19 thru CR24	See CR1		
CR25 CR26	See CR7		
CR27 CR28	See CR5		
CR29	See CR1		
CR30	See CR7		
CR31	See CR5		
CR32	See CR7		
CR33	See CR5		
CR34 CR35	See CR1		
CR36	See CR7		
CR37 CR38	See CR5		
CR39	See CR7		
CR40	See CR1		
CR41	See CR7		
CR42	See CR5		

*See "MANUFACTURERS' CODE LETTERS."

PARTS LIST

MODEL 3632

POWER AMPLIFIER - Continued

Component Designation	Description	Mfr.*	Mfr. Part No.
CR43	See CR1		
CR44	See CR5		
CR45	See CR7		
CR46 CR47	See CR1		
CR48	See CR18		
F1 F2	Fuse, 15 amp, cartridge	BUS	KAB-15
F3	Fuse, 2 amperes, 3AG, slow blow	L	313002
FL1 FL2 FL3	Filter, 10 amp, 130v ac	SP	10JX34
J1	Connector, receptacle, male, 22 contacts	ABE	MS3102A-28-11P
J2	Connector, receptacle, female, 5 contacts	ABE	MS3102A-18-11S
K1 K2	Relay, DPDT, 110v ac coil	PB	KRP11AG 115v ac
K3 K4	Relay, SPDT, 6v ac coil	PB	KRP5AG
K5	Relay, SPDT, 110v dc coil	PB	KRP5DG
L1	Reactor, filter, 8 mh, 10a, 0.05 ohm dc	TT	C-49U

*See "MANUFACTURERS' CODE LETTERS."

PARTS LIST

MODEL 3632

POWER AMPLIFIER - Continued

Component Designation	Description	Mfr.*	Mfr. Part No.
Q1 thru Q6	Transistor	RCA	2N1183
R1 R2 R7 R8 R12 R13	Resistor, fixed, composition, 47 ohms ±10%, 1/2w	O	LD
R3 thru R6 R9 R10 R11 R14 thru R24	Resistor, fixed, composition, 100 ohms ±10%, 1/2w	O	LD
R7 R8	See R1		
R9 R10 R11	See R3		
R12 R13	See R1		
R14 thru R24	See R3		
R25 R26 R28 R30	Resistor, fixed, wirewound, 2 ohms ±3%, 50w	DP	RH50
R27	Resistor, fixed, composition, 22 ohms ±10%, 1w	O	LD
R28	See R25		
R29 R32	Resistor, fixed, composition, 15 ohms ±10%, 1w	O	LD

*See "MANUFACTURERS' CODE LETTERS."

PARTS LIST

MODEL 3632

POWER AMPLIFIER - Continued

Component Designation	Description	Mfr.*	Mfr. Part No.
R30	See R25		
R31	Resistor, fixed, wirewound, 50 ohms ±3%, 10w	DP	RH10
R32	See R29		
T1 thru T6	Transformer, pulse, 1:1:1	SP	31Z382
T7 T8 T9	Transformer, filament, 115v pri., 6.3v @ 0.6a sec	TT	F-13X
XK1 XK2	Socket, 11-pin	ABE	77MIP11
XK3 thru XK5	Socket, octal	CM	8AM

*See "MANUFACTURERS' CODE LETTERS."

PARTS LIST

MODEL 3102-J77 PEDESTAL

SUBUNIT: ELEVATION UNIT

The component designations are abbreviated. Prefix each component with the number shown below.

2A2

Component Designation	Description	Mfr.*	Mfr. Part No.
B1	Motor, servo, 2 phase, 2 pole, 90v, 60 cps	DM	ZP105-2281-2
B2	Fan, 115v, 60 cps, 3400 RPM, 1 phase	DM	FBE-42-26-1
B3	Synchro, transmitter	BA	23TR6
B4	Synchro, control transformer	BA	23CT6
B5	Tachometer, dc, 6.5v per 1000 RPM	DM	FDE7-15-1
C1	Capacitor, 3 μf, 330v ac	CD	CRX 3030
C2 C3	Capacitor, feedthrough, 1500 μμf	CRL	CFC-1
J1	Connector, receptacle, male, 5 pins	ABE	MS3102A-18-11P
S1 S2	Switch, SPDT	MS	BZE6-2RQ8
S3	Switch, SPDT	MS	V3-601

*See "MANUFACTURERS' CODE LETTERS."

PARTS LIST

MODEL 3102-J77 PEDESTAL

SUBUNIT: ELEVATION UNIT-continued

The component designations are abbreviated. Prefix each component with the number shown below.

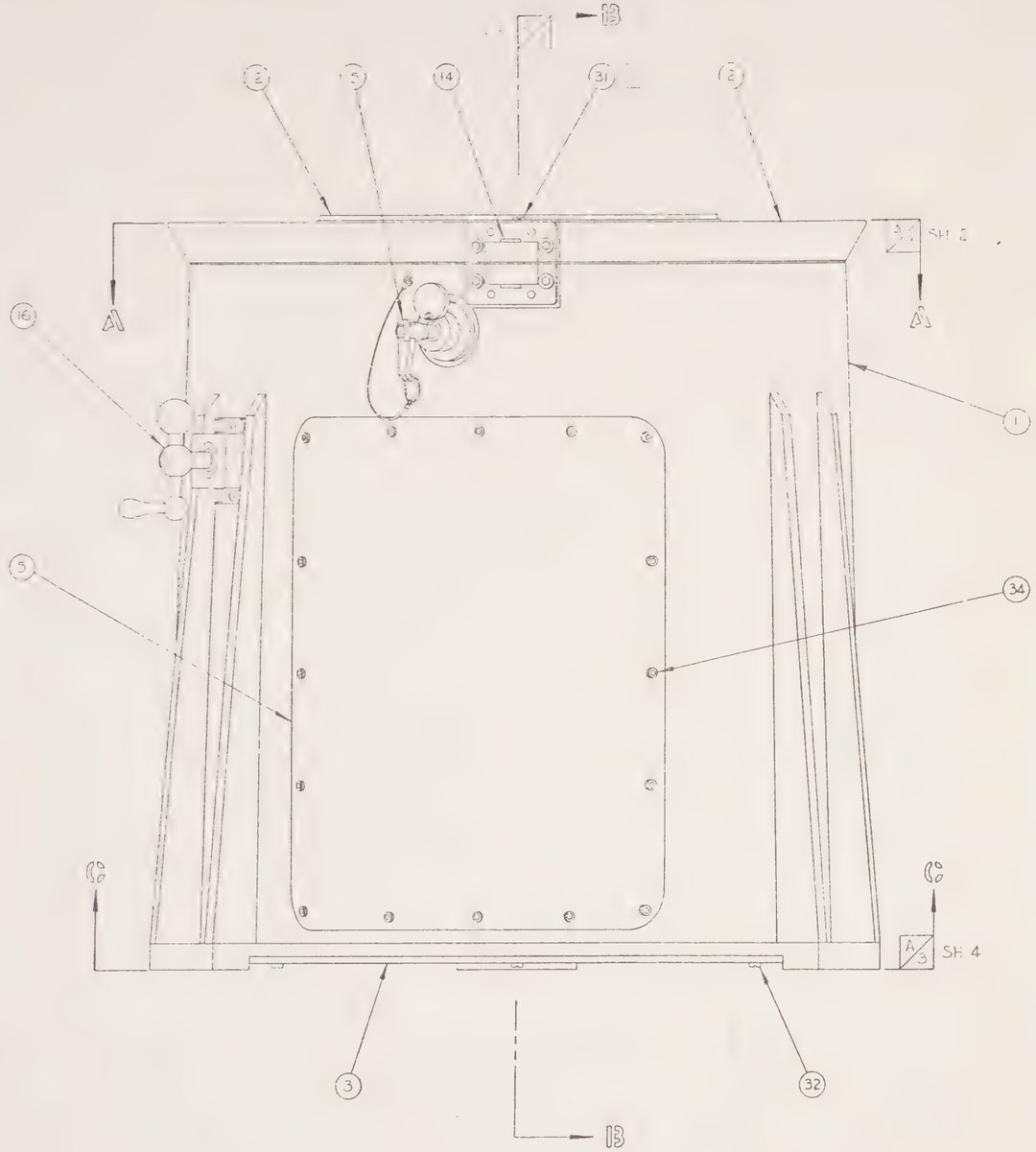
2A2

Component Designation	Description	Mfr.*	Mfr. Part No.
TB1	Terminal strip, barrier type, 20 terminals	CM	140-20
TB2	Terminal strip, barrier type, 2 terminals	CM	140-2

*See "MANUFACTURERS' CODE LETTERS."

SECTION 7
DRAWINGS AND DIAGRAMS

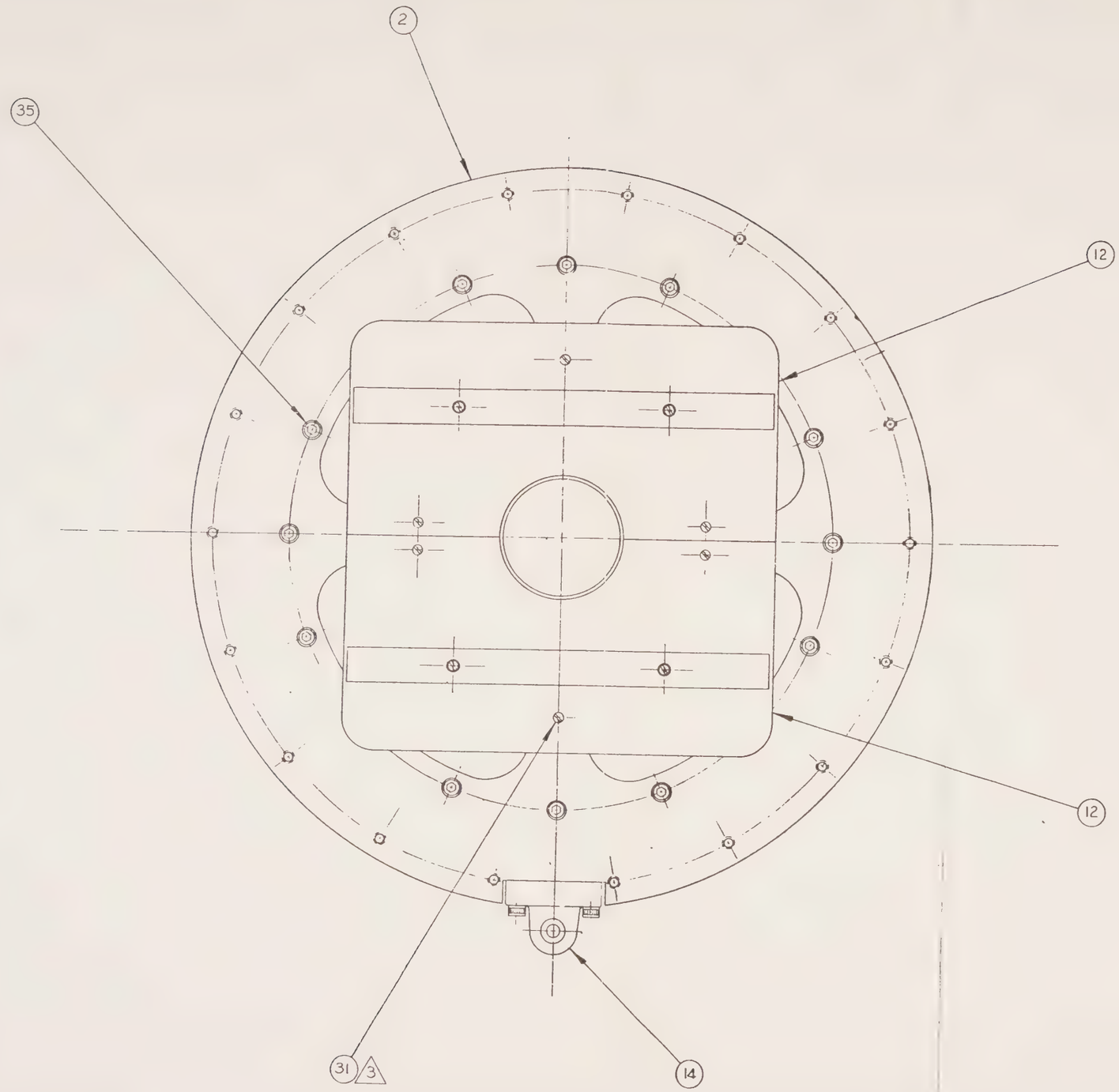
Drawings and diagrams necessary for the operation, understanding, and maintenance of Tracking Pedestal Set J-77, are located in this Section. The drawings pertaining to the pedestal contain the pedestal bills of material; the parts lists for the servo control and indicating system are located in Section 6.



QTY REQD	ITEM NO	NOMENCLATURE OR DESCRIPTION	MFR	IDENTIFYING OR PART NO	MATERIAL	STOCK SIZE	MATL SPEC
2	45	FLAT WASHER			SST	$\frac{3}{8}$	
4	44	STAR LOCK WASHER			SST	NO.6	
2	43	LOCK WASHER			SST	$\frac{3}{8}$	
6	42	LOCK WASHER			SST	$\frac{1}{4}$	
8	41	LOCK WASHER			SST	NO. 10	
4	40	LOCK WASHER			SST	NO. 10	
4	39	FLAT WASHER			SST	NO. 10	
8	38	HEX NUT			SST	NO.0-32	
2	37	HEX NUT			SST	$\frac{3}{8}$-6	
24	36	SCH CAP SCR			SST	$\frac{3}{8}$-16x$1\frac{1}{4}$	
12	35	SCH CAP SCR			SST	$\frac{3}{8}$-16x$1\frac{1}{2}$	
30	34	SCH CAP SCR			SST	$\frac{1}{4}$-20x$\frac{1}{2}$	
4	33	PAN HD CAP SCR			SST	NO.6-32x$\frac{1}{2}$	
8	32	PAN HD CAP SCR			SST	NO.10-24x$\frac{3}{8}$	
6	31	PAN HD CAP SCR			SST	NO.10-24x$\frac{1}{2}$	
8	30	PHILLIPS PAN HD CAP SCR			SST	NO.10-32x$\frac{3}{8}$	
6	29	HEX HD CAP SCR			SST	$\frac{1}{4}$-20x$\frac{3}{4}$	
4	28	HEX HD CAP SCR			SST	NO.10-24x$\frac{1}{2}$	
2	27	TAPER PIN			STL	NO.7x2	
	26						
	25						
1	24	SEALANT	PER	NO. 3	PERMATEX		
2	23	CABLE GRIP	OPT	CGB292			
1	22	SWITCH, LIMIT	SE	ER9441-E-1F			
1	21	MOTOR	SW	ZPM43-2234-2			
	20						
	19						
1	18	SWITCH, SECTOR	SA	TPSDM9387			
1	17	CONNECTOR BOX ASS'Y	SA	TPSDM12835			
1	16	HAND DRIVE ASSY	SA	TPSDM12575			
1	15	BRAKE RELEASE ASS'Y	SA	TPSDM 2371			
1	14	STOW-LOCK ASSY	SA	TPSDM11949			
1	13	GEAR BOX ASSY	SA	TPSDM 2356			
2	12	COVER PLATE ASSY	SA	TPSDM12787			
1	11	SEAL	SA	EMB1850			
1	10	GEAR, SYNCHRO	SA	EM23CM9205			
1	9	BEARING	SA	EMB1551			
2	8	BRACKET, LIMIT SW	SA	EMC3456			
2	7	GEAR, LIMIT SW	SA	EMA1514			
8	6	GASKET	SA	TPSDM11952			
1	5	ACCESS DOOR	SA	TPSDM12354			
1	4	ACCESS DOOR	SA	TPSDM11951			
1	3	COVER PLATE	SA	TPSDM11822			
1	2	TURNTABLE	SA	TPSDM11821			
1	1	HOUSING	SA	TPSDM11935			

LIST OF MATERIAL (PARTS LIST)

Fig. 7.1.1. Pedestal Azimuth Assembly (Sheet 1 of 4)



VIEW A-A C/2 SH 1

Fig. 7.1.2. Pedestal Azimuth Assembly (Sheet 2 of 4)

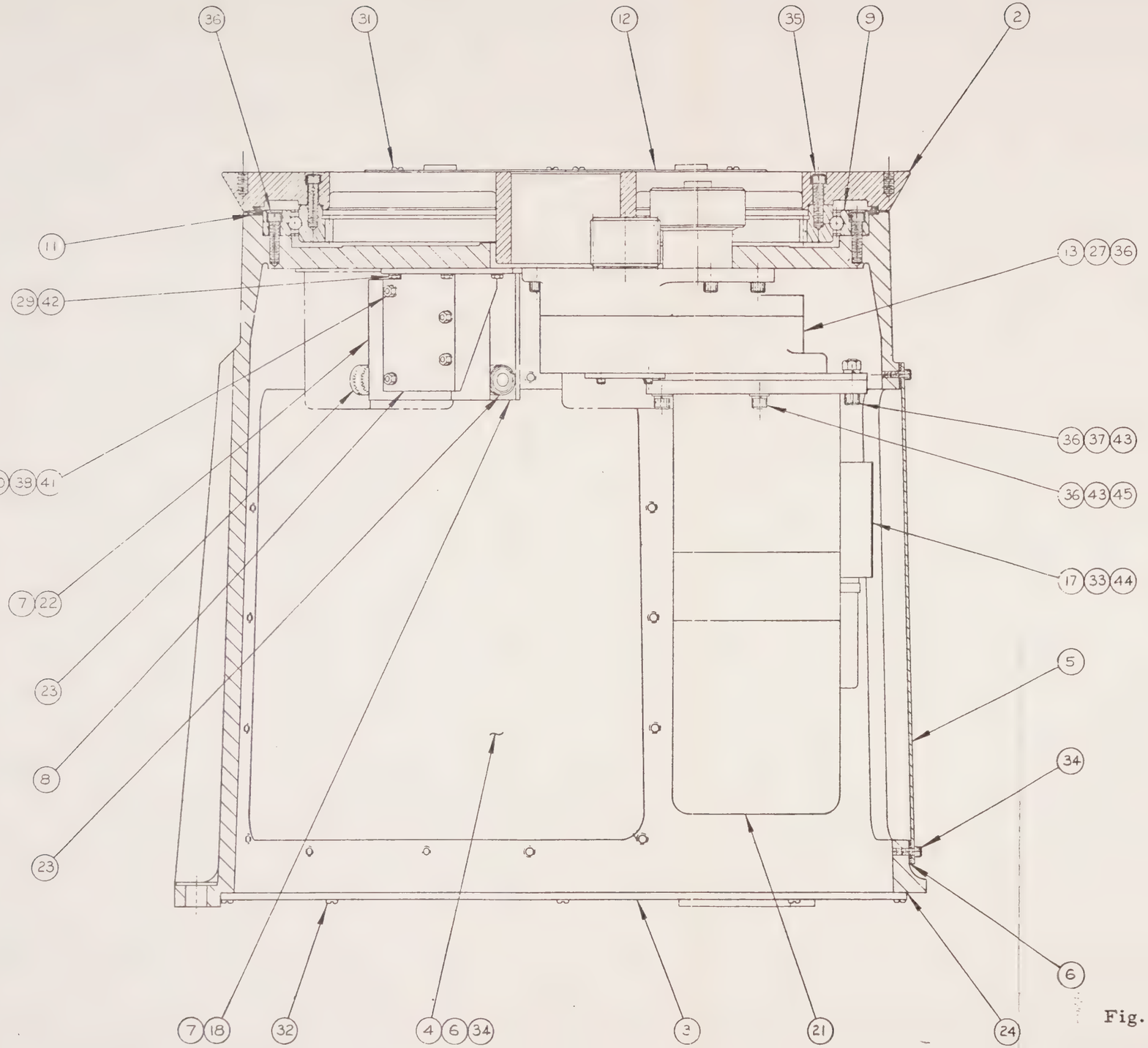
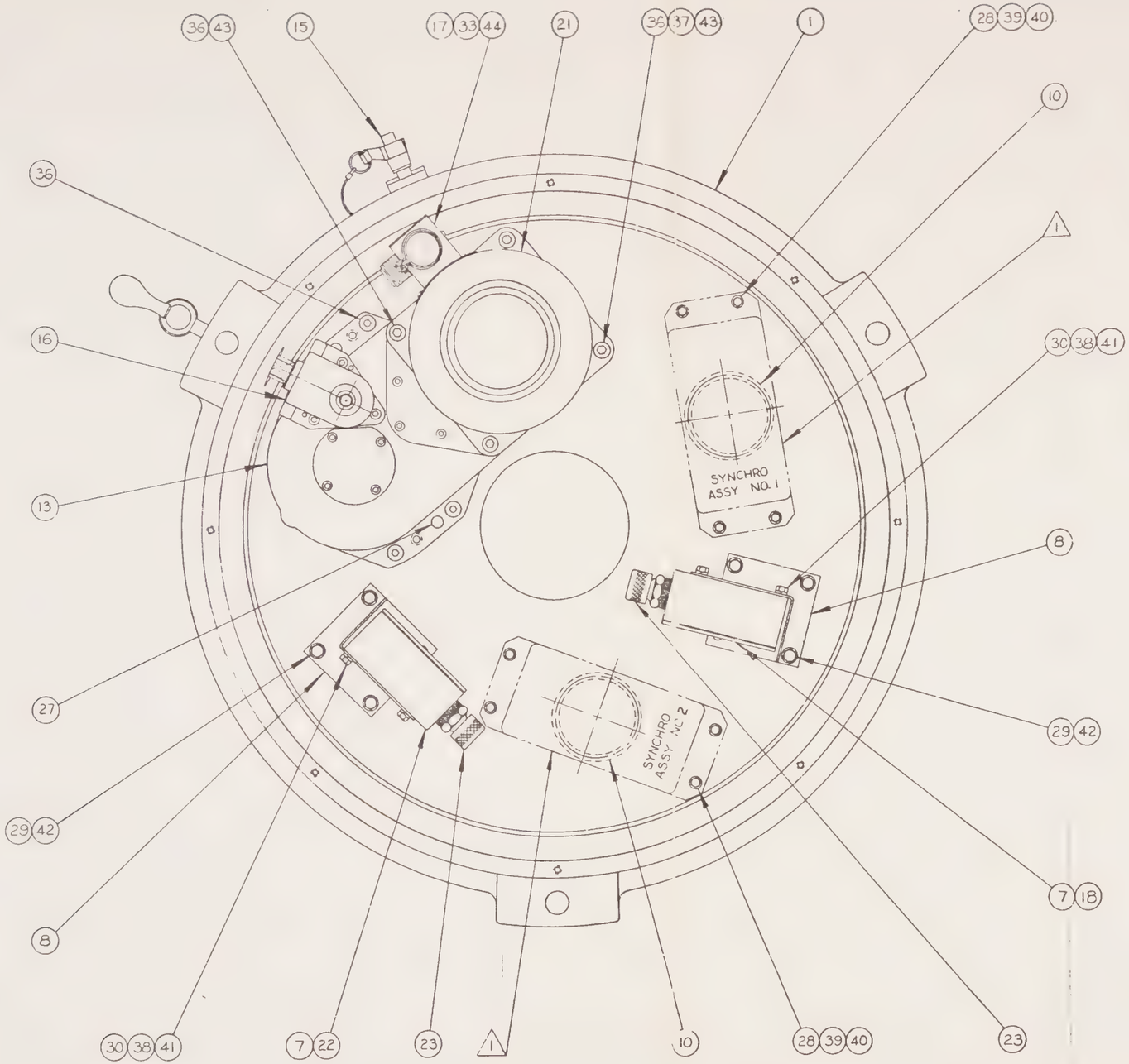
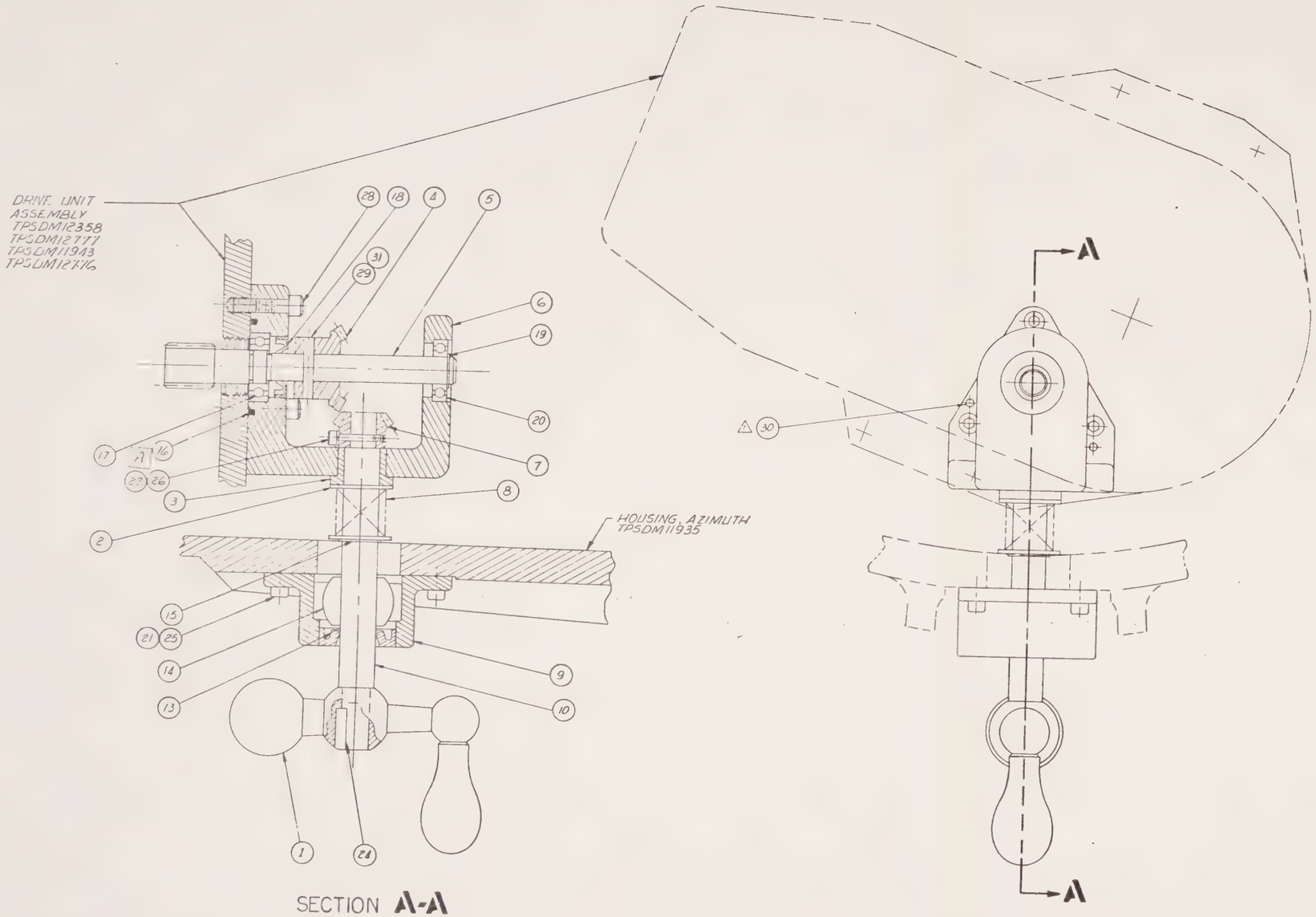


Fig. 7.1.3. Pedestal Azimuth Assembly (Sheet 3 of 4)



VIEW C-C A/2 SH 1
(WITH COVER REMOVED)

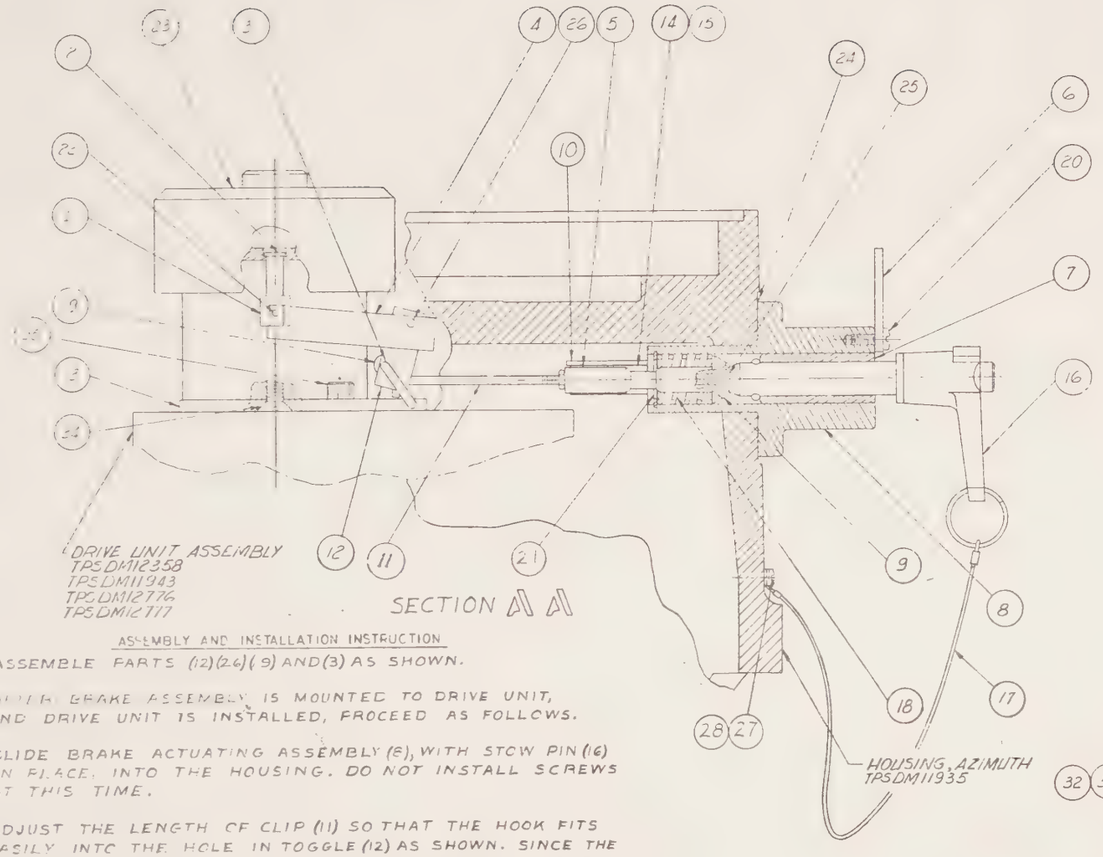
Fig. 7.1.4. Pedestal Azimuth Assembly (Sheet 4 of 4)

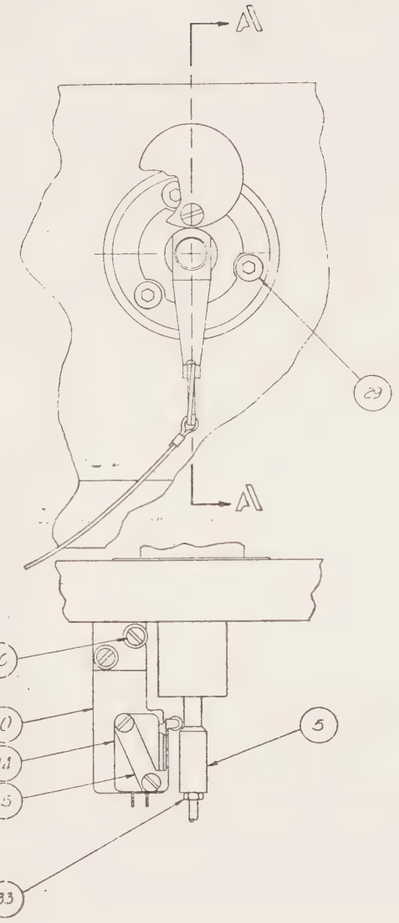


QTY REQD	ITEM NO	NOMENCLATURE OR DESCRIPTION	MFG	IDENTIFYING OR PART NO	MATERIAL	STOCK SIZE	MATL SPEC.
1	31	SET SCREW		#10-24 x 1/4 LG	SST		
2	30	DOWEL		1/8 DIA x 1/2 LG	STL		
1	29	DOWEL		3/16 DIA x 1/4 LG	STL		
3	28	SCR. CAP, SCH		1/4-20 x 3/8 LG	SST		
1	27	LOCK WASHER		#8	SST		
1	26	SCR, CAP, SCH		8-32 x .7 LG	SST		
4	25	SCR. CAP, SCH		10-24 x 3/8 LG	SST		
1	24	PIN		3/16 DIA x 3/4 LG	SST,GP		
	23						
	22						
2	21	DOWEL		3/16 DIA x 3/8 LG	STL		
1	20	BEARING	FB	S5PP			
1	19	RETAINING RING	WK	5100-50			
1	18	OIL SEAL	VM	K36-#65055			
1	17	BEARING	FB	9102NPP			
1	16	"O" RING	VM	72127			
1	15	RETAINING RING	WK	5100-62			
1	14	ALINABAL	SPB	CB-10-A			
1	13	SEAL	GA	63-91			
	12						
	11						
1	10	SHAFT, HAND DRIVE	SA	TPSBM12576			
1	9	BLOCK, BEARING	SA	TPSBM12582			
1	8	SPRING	SA	TPSBM12369			
1	7	GEAR, MITER	SA	TPSBM12779			
1	6	SHAFT SUPPORT	SA	TPSDM11933			
1	5	PINION	SA	TPSDM11946			
1	4	GEAR, MITER	SA	TPSBM12773			
1	3	BEARING	SA	TPSBM12574			
2	2	WASHER	SA	TPSBM12573			
1	1	HANDLE	SA	TPSBM12361			

LIST OF MATERIALS OR PARTS LIST

Fig. 7.2. Azimuth Hand Drive Assembly





A

ASSEMBLY AND INSTALLATION INSTRUCTION

1. ASSEMBLE PARTS (12)(24)(9) AND (3) AS SHOWN.

2. AFTER BRAKE ASSEMBLY IS MOUNTED TO DRIVE UNIT, AND DRIVE UNIT IS INSTALLED, PROCEED AS FOLLOWS.

3. SLIDE BRAKE ACTUATING ASSEMBLY (8), WITH STOW PIN (16) IN PLACE, INTO THE HOUSING. DO NOT INSTALL SCREWS AT THIS TIME.

4. ADJUST THE LENGTH OF CLIP (11) SO THAT THE HOOK FITS EASILY INTO THE HOLE IN TOGGLE (12) AS SHOWN. SINCE THE ASSEMBLY IS NOT FASTENED IN PLACE AT THIS TIME, THE UNIT MAY BE REMOVED EASILY FOR ADJUSTMENT AFTER EACH TRIAL FIT. ADJUSTMENT MUST BE MADE SO THAT THE BRAKE RELEASE YOKE (4) MAINTAINS ITS FREEDOM TO MOVE UP AND DOWN SLIGHTLY (ABOUT $\frac{1}{16}$).

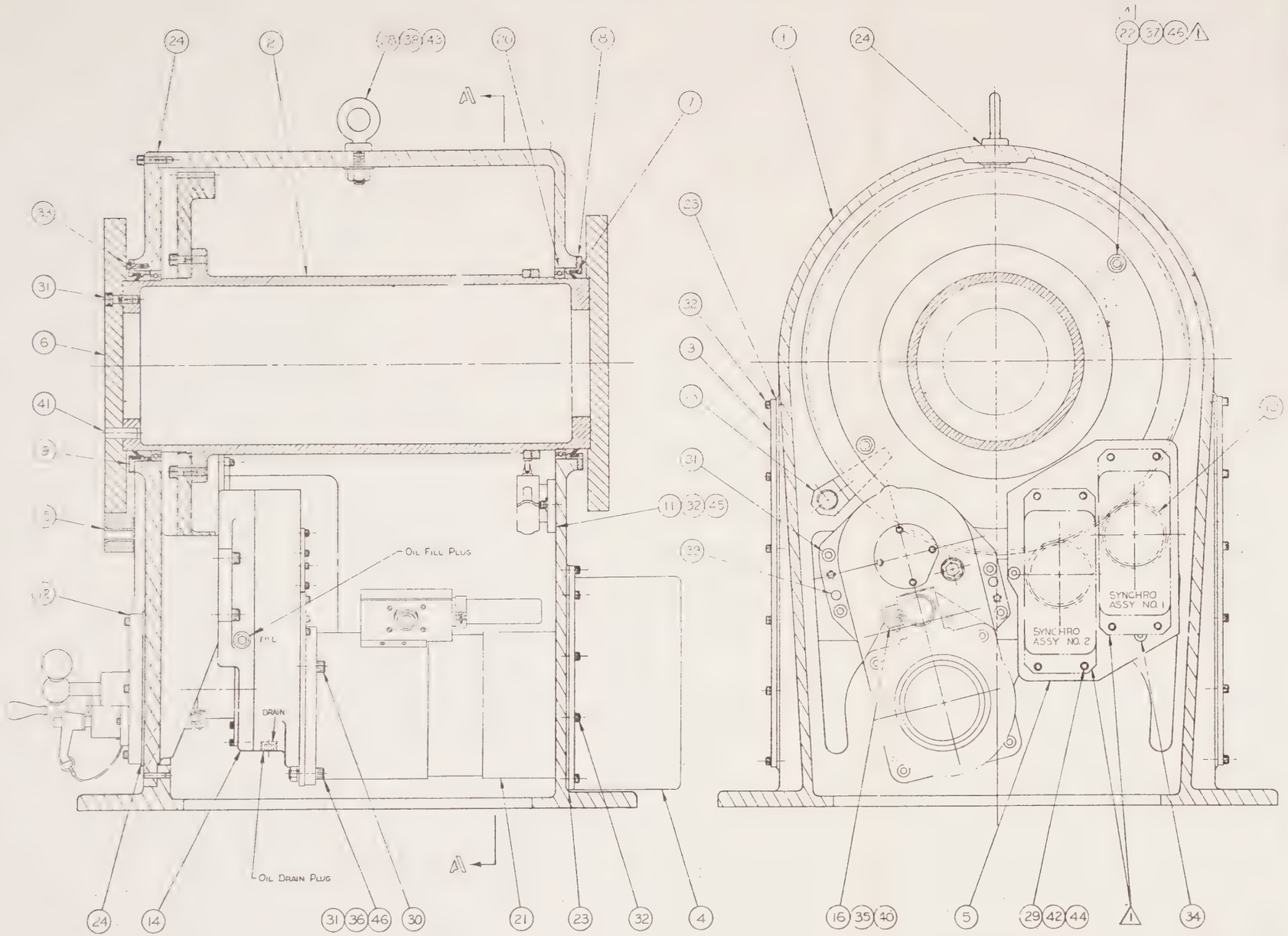
5. ADJUST SWITCH (14) SO THAT IT IS ACTUATED BY THE ACTUATOR ROD (5) WHEN THE STOW PIN IS REMOVED.

6. AFTER ALL ADJUSTMENTS HAVE BEEN MADE, AND THE YOKE MOVEMENT HAS BEEN CHECKED, FASTEN ACTUATING ASSEMBLY IN PLACE

QTY REQD	ITEM NO	NOMENCLATURE OR DESCRIPTION	MFG	DRAWING OR PART NO	MATERIAL	STOCK SIZE	MATL SPEC
2	35	SCR SCH CAP		NAS-[illegible]	SST		
3	34	SCR SLOTTED FH		[illegible]	SST		
1	33	NUT		[illegible]	SST		
2	32	FLAT WASHER		#8	SST		
2	31	FLAT WASHER		#6	SST		
2	30	SCREW, PAN HD.		[illegible]	SST		
3	29	SCREW, SCH		[illegible]	SST		
1	28	FLAT WASHER		#4	SST		
1	27	SCREW, PAN HD.		[illegible]	SST		
1	26	DOWEL PIN		[illegible]	SST		
1	25	FLAT HD SCREW		[illegible]	SST		
1	24	THERMISTER	PER	[illegible]			
1	23	BRUSH	STL	[illegible]			
2	22	DOWEL PIN	ES	[illegible]			
1	21	O-RING	MS	[illegible]			
1	20	SHOULDER SCREW	PIC	[illegible]			
1	19	RETAINING RING	WK	[illegible]			
1	18	SPRING	ASI	[illegible]	SST		
1	17	CABLE	CAN	[illegible]			
1	16	DOWEL PIN	MS	[illegible]			
1	15	ACTUATOR	MS	[illegible]			
1	14	MICRO SWITCH	MS	[illegible]			
1	13	MOUNT	SA	[illegible]			
1	12	TOGGLE CLIP	SA	[illegible]			
1	11	ACTUATOR CLIP	SA	[illegible]			
1	10	BRACKET, SWITCH	SA	[illegible]			
1	9	STOP PIN	SA	[illegible]			
1	8	RECEPTACLE	SA	[illegible]			
1	7	BUSHING	SA	[illegible]			
1	6	COVER	SA	[illegible]			
1	5	ROD, ACTUATOR	SA	[illegible]			
1	4	YOKE	SA	[illegible]			
1	3	TOGGLE CLIP	SA	[illegible]			
2	2	PIN	SA	[illegible]			
2	1	CLIP, FULCRUM	SA	[illegible]			

LIST OF MATERIALS OR PARTS LIST

Fig. 7.3. Azimuth Brake Release Assembly

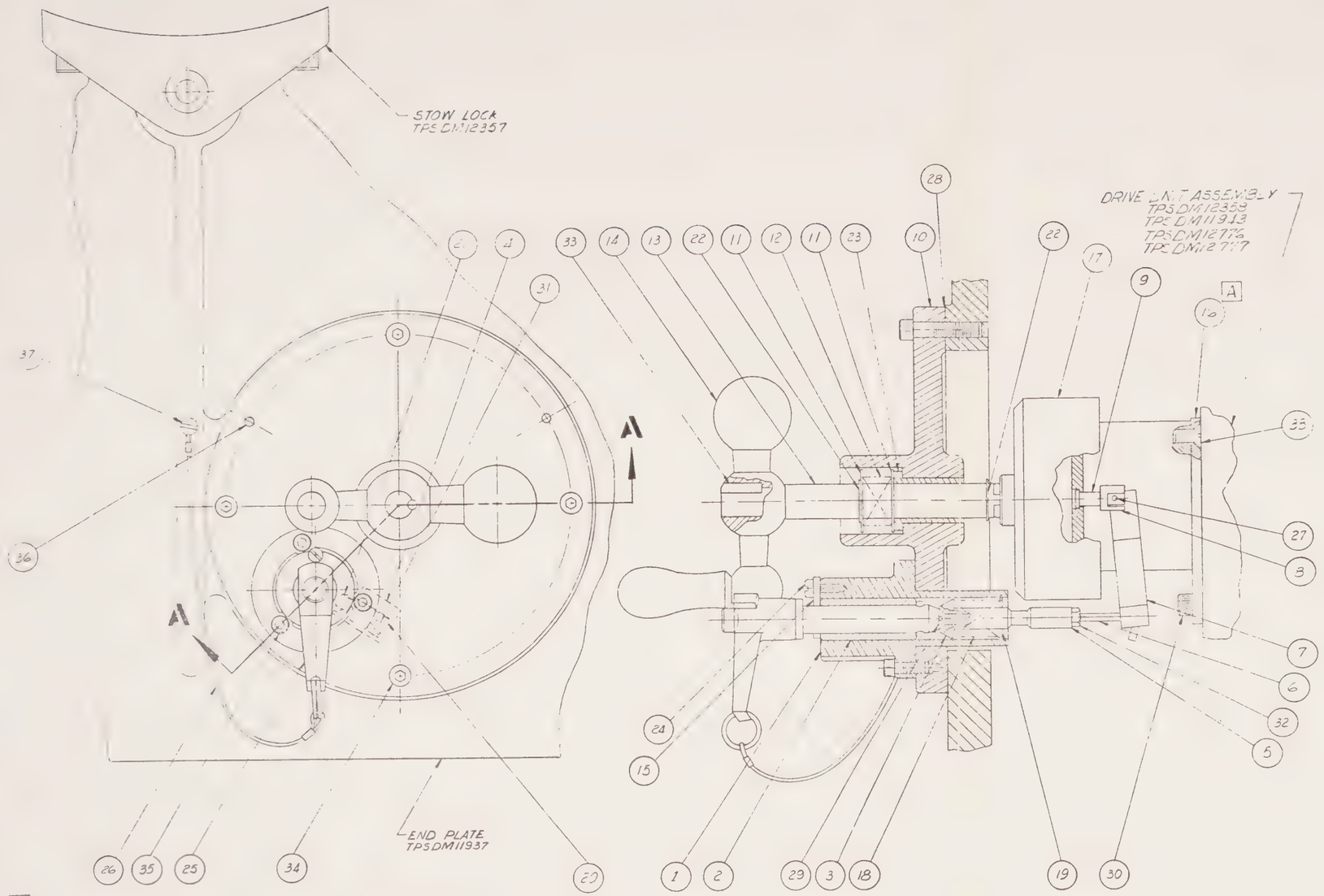


NOTE:
2. FOR ELECTRICAL SCHEMATIC DWG SEE E.E. DEPT
⚠ FOR INFORMATION SEE ENGINEERING DEPT

QTY REQD	ITEM NO	NOMENCLATURE OR DESCRIPTION	MFR IDENTIFYING DR PART NO	MATERIAL	STOCK SIZE	MATL SPEC.
4	46	LOCK WASHER		SST	$\frac{5}{8}$	
2	45	LOCK WASHER		SST	$\frac{1}{4}$	
⚠	44	LOCK WASHER		SST	NO. 10	
1	43	FLAT WASHER		SST	$\frac{1}{2}$	
⚠	42	FLAT WASHER		SST	NO. 10	
4	41	DOWEL PIN		STL	$\frac{5}{16} \times 1\frac{1}{2}$	
4	40	SPLIT LOCK WASHER		SST	NO. 6	
2	39	TAPER PIN		STL	NO. 7 × 2	
1	38	HEX HD NUT		SST	$\frac{5}{8}$-18	
2	37	HEX HD NUT		SST	$\frac{1}{4}$-24	
2	36	HEX HD NUT		SST	$\frac{5}{8}$-18	
4	35	PAN HD SCR		SST	NO. 6-32 × $\frac{1}{4}$	
4	34	FH SOCKET CAP SCR		SST	$\frac{1}{4}$-20 × $\frac{5}{8}$	
32	33	SCH CAP SCR		SST	NO. 5-24 × $\frac{3}{8}$	
47	32	SCH CAP SCR		SST	$\frac{1}{4}$-20 × $\frac{3}{8}$	
22	31	SCH CAP SCR		SST	$\frac{5}{8}$-18 × $1\frac{1}{4}$	
2	30	SCH CAP SCR		SST	$\frac{5}{8}$-18 × 1	
⚠	29	SCH CAP SCR		SST	NO. 10-24 × $\frac{1}{2}$	
1	28	EYE BOLT	INCL NO. 25	STL		
	27					
	26					
	25					
1	24	SEALANT	REF SUPER 300	PERMATEX	AS REQD	
1	23	GASKET	FILE NO. 11	SEGELITE	AS REQD	
2	22	CAM FOLLOWER	SKM4775			
1	21	MOTOR	SM-P43-2294-2			
2	20	BEARING	ADBOXWG			
	19					
	18					
	17					
1	16	CONNECTOR BOX ASSY	PSMCE12835			
1	15	STOW-LOCK ASSY	PSDM12357			
1	14	GEAR BOX ASSY	PSDM12358			
1	13	TORSION BAR ASSY	⚠			
1	12	HAND DRIVE & BRAKE RELEASE ASSY	PSDM12370			
1	11	LIMIT SWITCH ASSY	PSCM11813			
⚠	10	SYNCHRO GEAR	PSCM9205			
1	9	RETAINING RING	PSCM11817②			
1	8	RETAINING RING	PSCM11817①			
2	7	SEAL	PAMB650			
2	6	TURNTABLE	PSMII29			
1	5	MOUNTING PLATE	PSMII28			
1	4	MOTOR COVER	PSMII98			
2	3	ACCESS DOOR	PSMII16			
1	2	SHAFT ASSY	PSMII45			
1	1	HOUSING ASSY	PSMII38			

LIST OF MATERIAL OR PARTS LIST

Fig. 7.4. Pedestal Elevation Assembly



SECTION A-A

B

ASSEMBLY AND INSTALLATION INSTRUCTIONS

1. AFTER INSTL OF DRIVE UNIT WITH BRAKE ASSY MOUNTED. POSITION ADAPTER (10) SO THAT SHAFT (13) CENTERS IN BRAKE SHEET END HOLE FOR ACTUATING ASSY LINES UP WITH END OF YOKE (7)

2. SLIDE BRAKE ACTUATING ASSEMBLY (11), WITH STOW PIN (25) IN PLACE INTO THE HOUSING. DO NOT INSTALL SCREWS (35) AT THIS TIME.

3. ADJUST THE LENGTH OF CLIP (6) SO THAT THE HOOK FITS EASILY INTO THE HOLE IN YOKE (7) AS SHOWN. SINCE THE ASSEMBLY IS NOT FASTENED IN PLACE AT THIS TIME, THE UNIT MAY BE REMOVED EASILY FOR ADJUSTMENT AFTER EACH TRIAL FIT. ADJUSTMENT MUST BE MADE SO THAT THE BRAKE RELEASE YOKE (7) MAINTAINS ITS FREEDOM TO MOVE UP AND DOWN SLIGHTLY (ABOUT $\frac{1}{16}$).

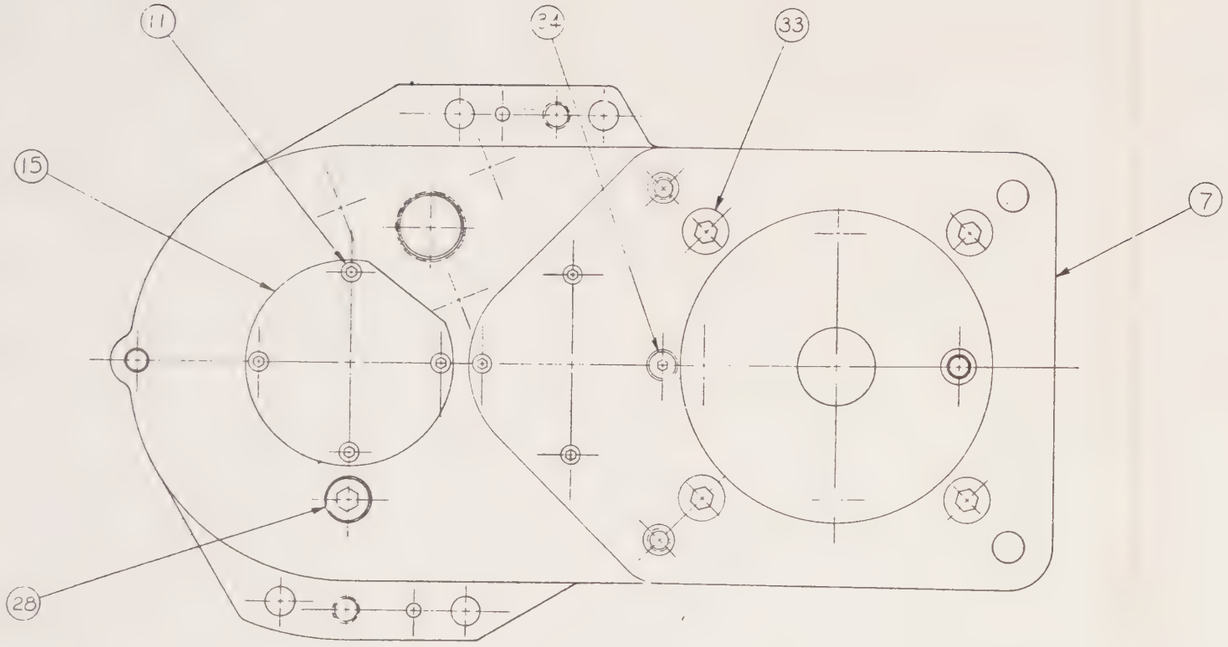
4. ADJUST SWITCH (20) SO THAT IT IS ACTUATED BY THE ACTUATOR ROD (5) WHEN THE STOW PIN (25) IS REMOVED

5. CHECK YOKE MOVEMENT AND FASTEN ACTUATING ASSEMBLY IN PLACE.

QTY REQD	ITEM NO	NOMENCLATURE OR DESCRIPTION	MFG	IDENTIFYING OR PART NO	MATERIAL	STOCK SIZE	MATL SPEC
3	38	SCR. FLAT HD.		4-40 x 1/8 LG	SST		
1	37	SCR. PAN HD.		4-40 x 3/16	SST		
2	36	DOWEL PIN		3/16 x 1/2			
3	35	SCR. CAP. SCH		10-24 x 5/8	SST		
4	34	SCR. CAP. SCH		3-48 x 1/4 LG	SST		
1	33	PIN		5/64 x 1/2 LG	SST. GAP		
1	32	NUT		5-40	SST		
2	31	SCREW. PAN HD.		6-32 x 3/8 LG	SST		
2	30	SCR. CAP. SCH		4-40 x 3/16	SST		
1	29	FLAT HD. SCREW		8-32 x 5/8 LG	SST		
1	28	PERMATEX	PER	SUPER 300			
2	27	ROLL PIN	ES	S2393-078-05			
1	26	CABLE	CLM	CL-22-4A-800			
1	25	BALL-PIN	VSM	VPBCL205			
1	24	SHOULDER SCREW	PIC	4315			
1	23	BEARING	BG	FB1013-10			
2	22	RETAINING RING	WK	5100-62			
1	21	ACTUATOR	MS	JY-5			
1	20	MICRO-SWITCH	MS	V3-G01			
1	19	SNAP-RING	WK	N-5000-75			
1	18	SPRING	ASC	C720-067-2000	SST		
1	17	BRAKE	STL	057-56-01045			
1	16	MOUNTING PLATE	SA	TPSBM11603			
1	15	COVER	SA	TPSAM112367			
1	14	HANDLE	SA	TPSBM12361			
1	13	SHAFT	SA	TPSBM12368			
1	12	SPRING	SA	TPSBM12369			
2	11	WASHER	SA	TPSAM12573			
1	10	ADAPTER, DRIVE	SA	TPSCM11945			
2	9	PIN	SA	TPSBM12363			
2	8	CLIP, FULCRUM	SA	TPSBM12362			
1	7	YOKE	SA	TPSBM12364			
1	6	ACTUATOR LINK	SA	TPSBM12582			
1	5	ROD, ACTUATOR	SA	TPSBM12583			
1	4	BRACKET	SA	TPSBM12552			
1	3	STOP, PIN	SA	TPSBM12580			
1	2	BUSHING	SA	TPSAM12366			
1	1	RECEPTACLE	SA	TPSCM12365			

LIST OF MATERIALS OR PARTS LIST

Fig. 7.5. Elevation Hand Drive and Brake Release Assembly

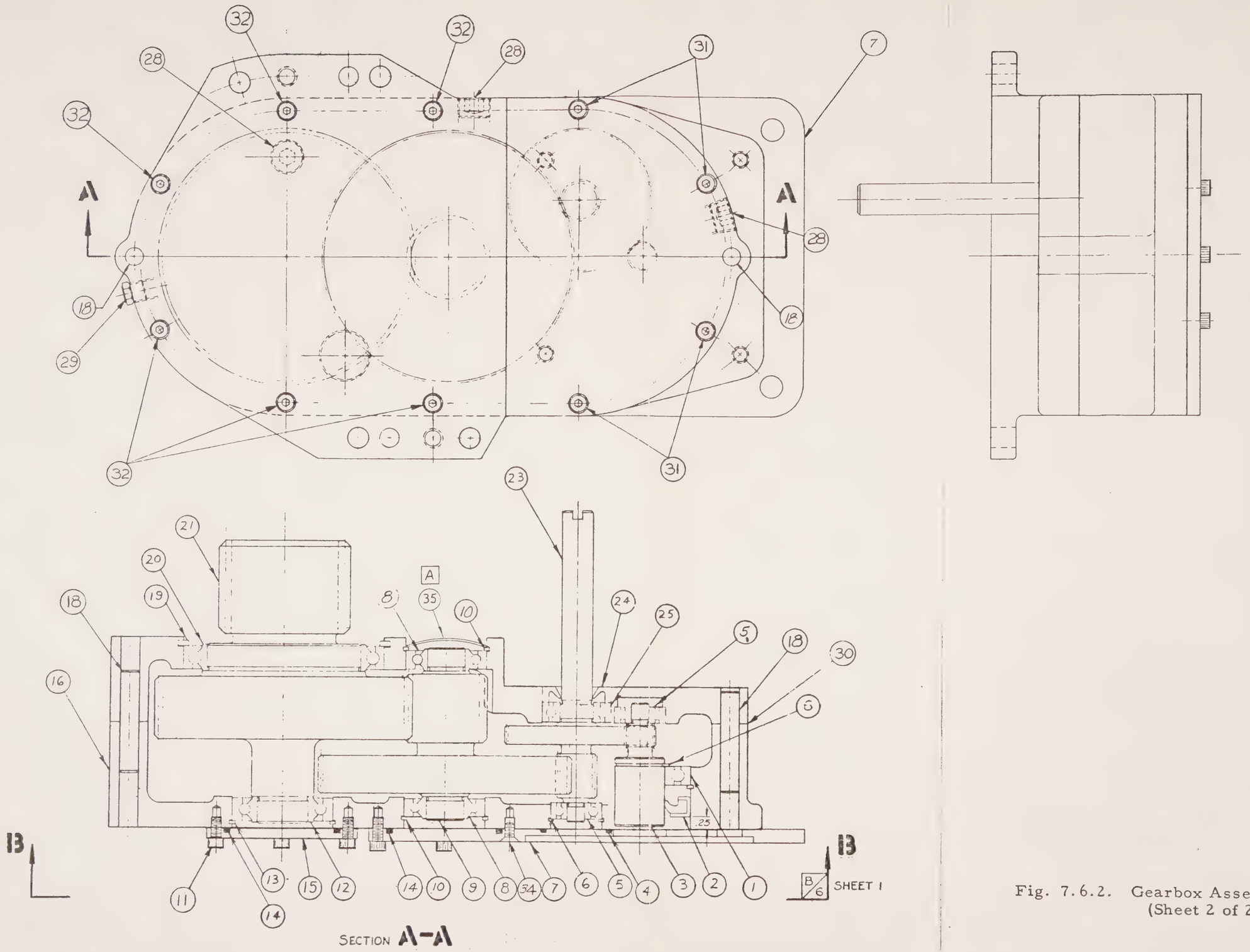


VIEW 13-13 A/4 SHEET 2

QTY REQ'D	ITEM NO	NOMENCLATURE OR DESCRIPTION	MFG.	IDENTIFYING OF PART NO	MATERIAL	SIZE	MATL SPEC.
	35	EXTENSION PLUG	AL	[illegible]		[illegible]	
4	34	FH SOC CAP SCR			SST	10-24 x 3/8	
4	33	FH SOC CAP SCR			SST	10-24 x 5/8	
6	32	SCH CAP SCR			SST	10-24 x 2	
4	31	SCH CAP SCR			SST	10-24 x 1	
1	30	PERMATEX	PER	[illegible]			
1	29	SAFETY VENT PLUG	[illegible]	[illegible] NO 5827		1/8 NPT	
3	28	PIPE PLUG				1/8 NPT	
	27						
	26						
1	25	BEARING	FB	9103PP			
1	24	SEAL	GA	63X91			
1	23	COMPOUND GEAR	SA	TPSM-595			
	22						
1	21	COMPOUND GEAR	SA	TPSM-593			
1	20	BEARING	FB	KF19B			
1	19	RETAINER RING	WK	5030-400			
2	18	DOWEL PIN			STL	5/16 X 2	
	17						
1	16	HOUSING	SA	TPSM-542			
1	15	BEARING COVER	SA	TPSW12355			
2	14	O RING	VM	72.38			
1	13	RETAINER RING	WK	5030-200			
1	12	BEARING	FB	KF16A			
7	11	SCH CAP SCR			SST	10-24 x 3/4	
2	10	RETAINER RING	WK	5000-162			
1	9	COMPOUND GEAR	SA	TPSM-534			
2	8	BEARING	FB	KF12A			
1	7	MOTOR ADAPTER	SA	TPSW-347			
3	6	RETAINER RING	WK	5100-100			
2	5	BEARING	FB	3SN22			
1	4	O RING	VM	72026			
1	3	PINION	SA	TPSM-535			
1	2	SEAL	GA	63X91			
1	1	BEARING	FB	5104			

LIST OF MATERIALS OR PARTS LIST

Fig. 7.6.1. Gearbox Assembly
(Sheet 1 of 2)



SECTION A-A

Fig. 7.6.2. Gearbox Assembly
(Sheet 2 of 2)

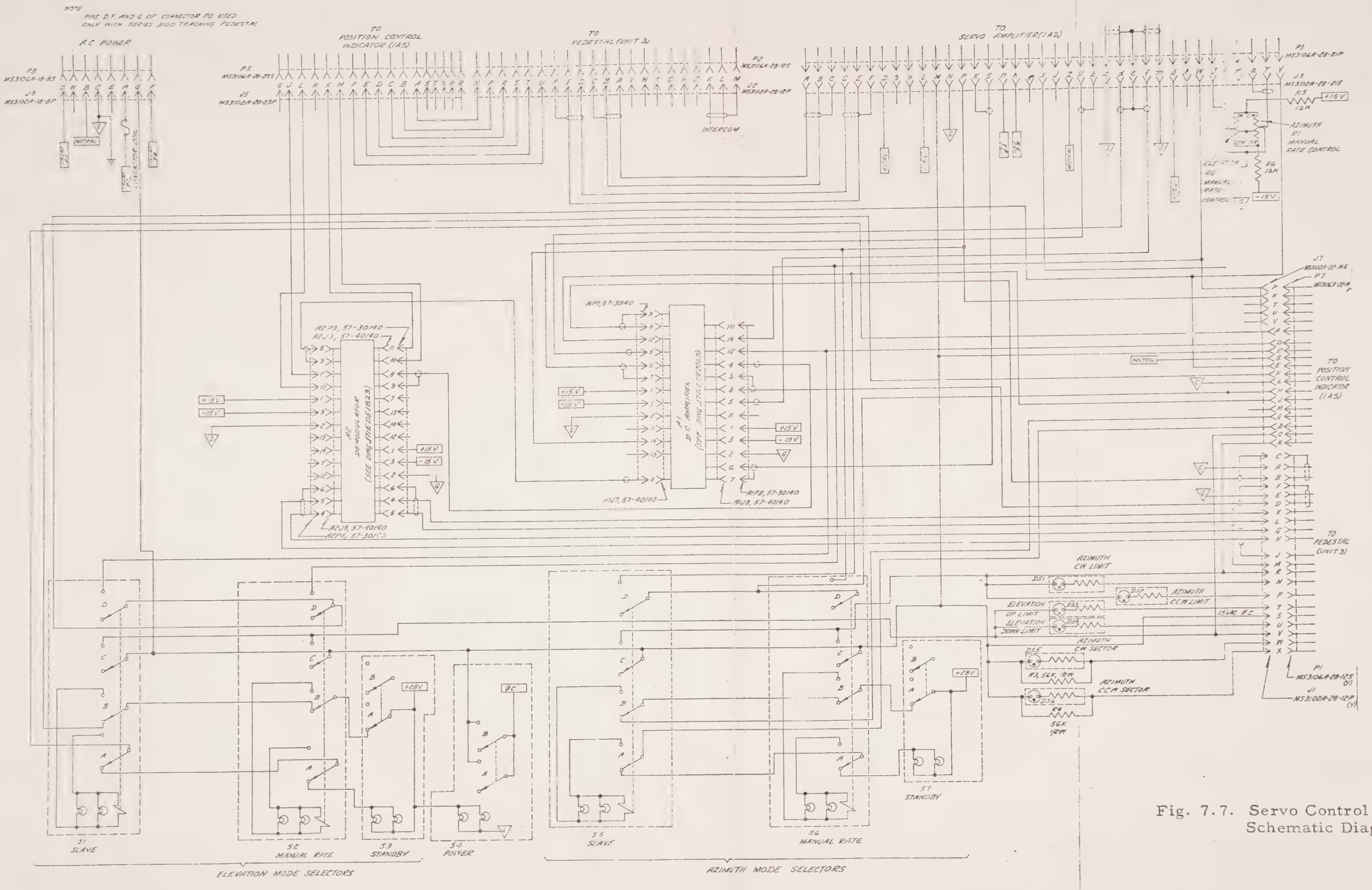


Fig. 7.7. Servo Control Unit Schematic Diagram

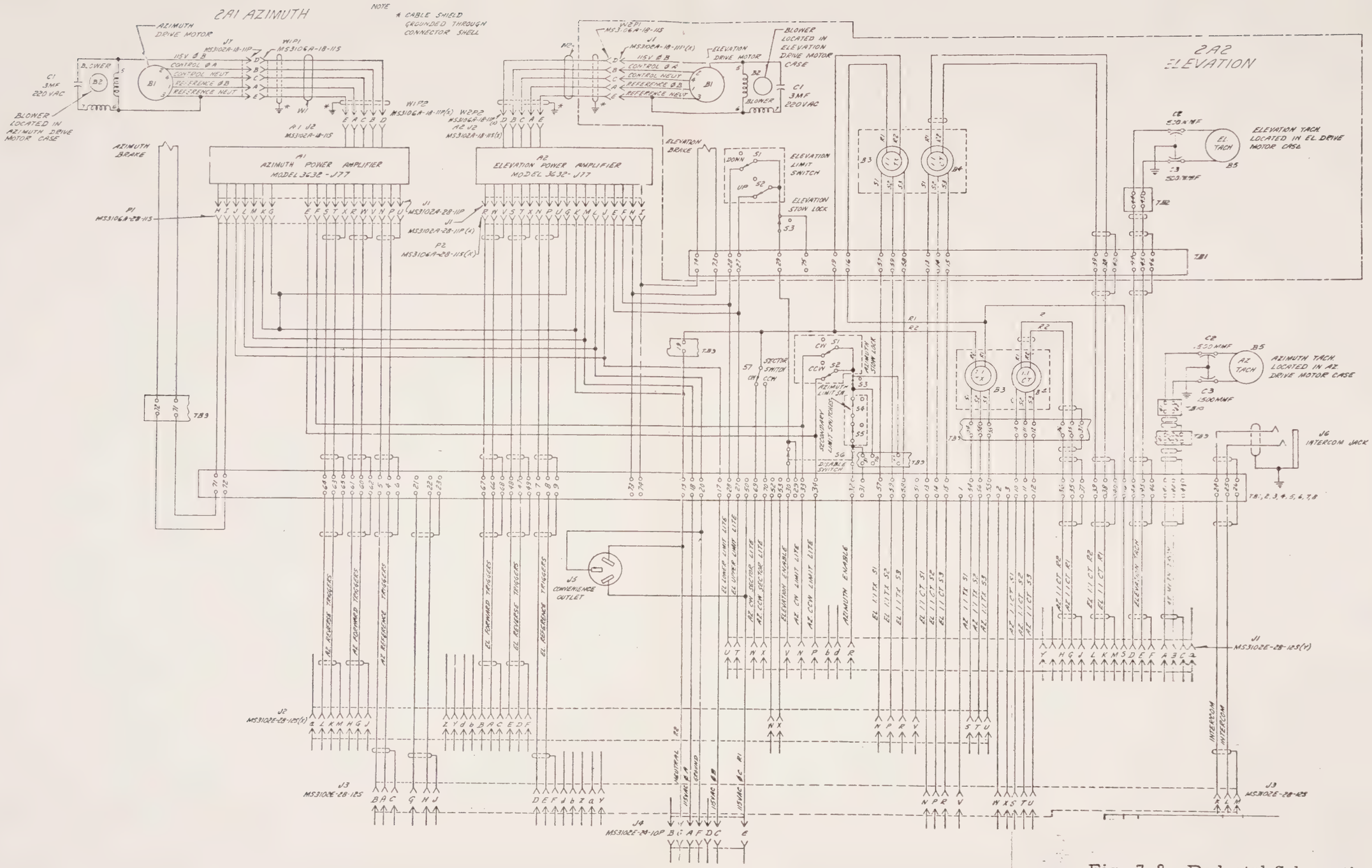


Fig. 7.8. Pedestal Schematic Diagram

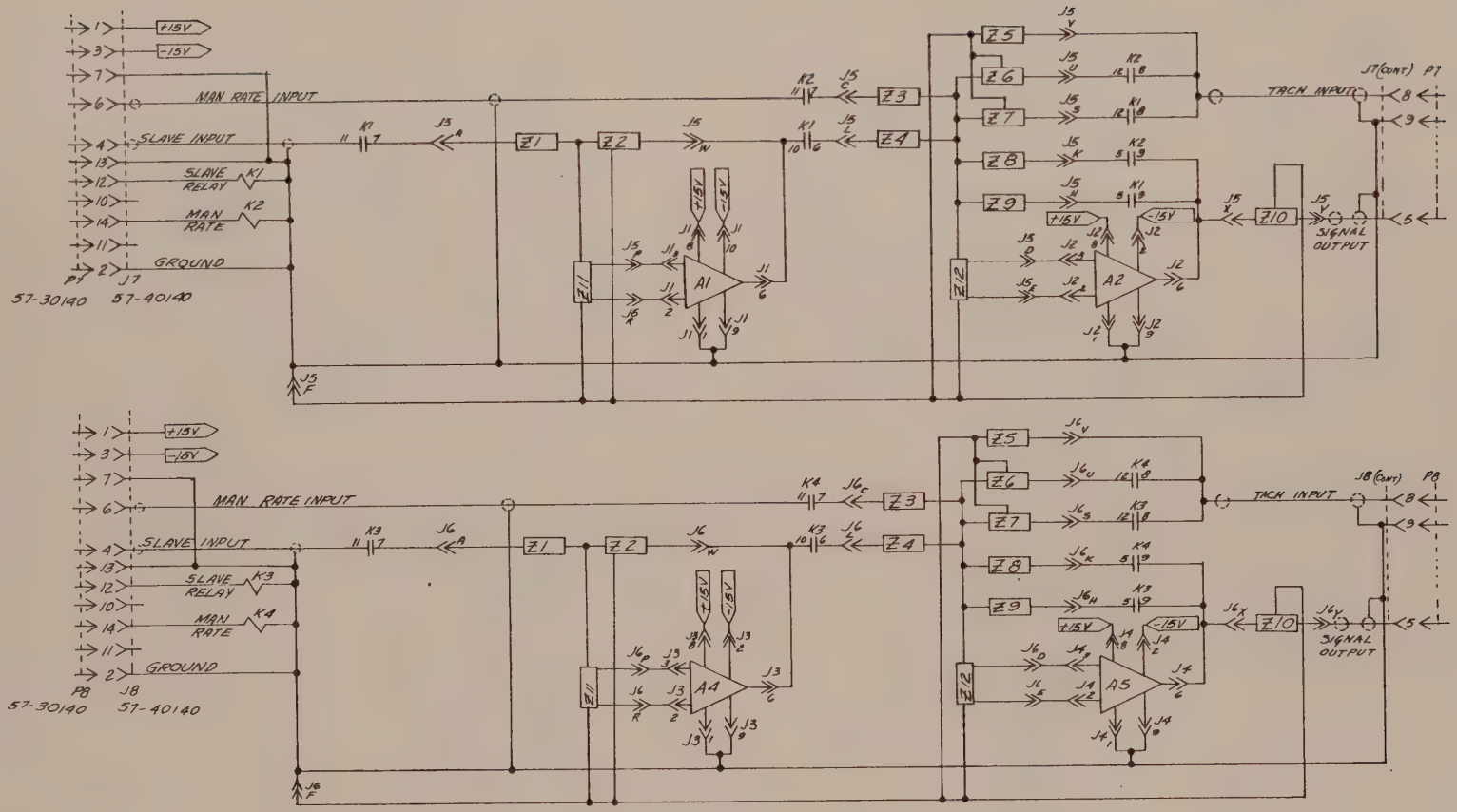
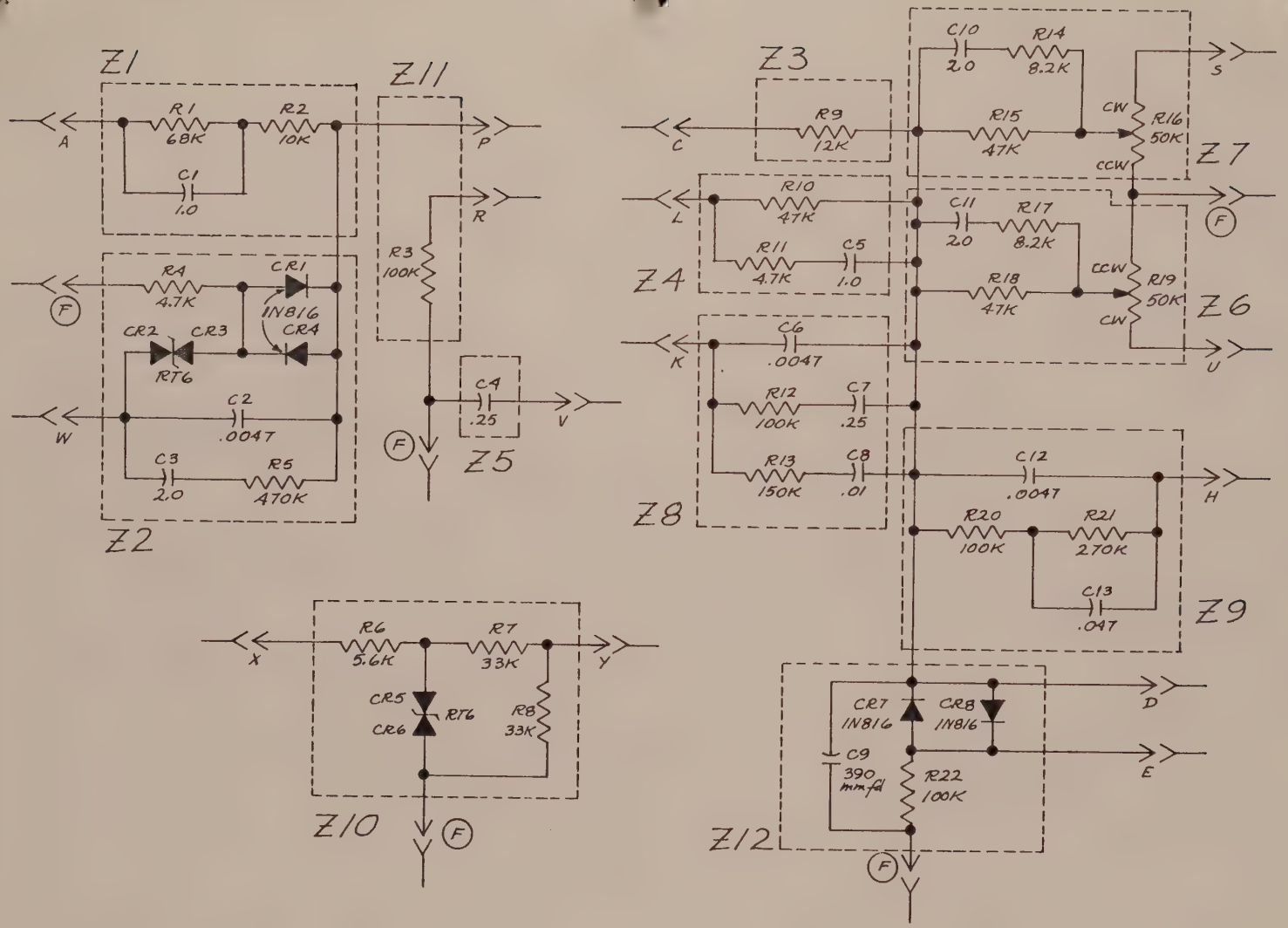


Fig. 7.9. DC Amplifier Schematic Diagram

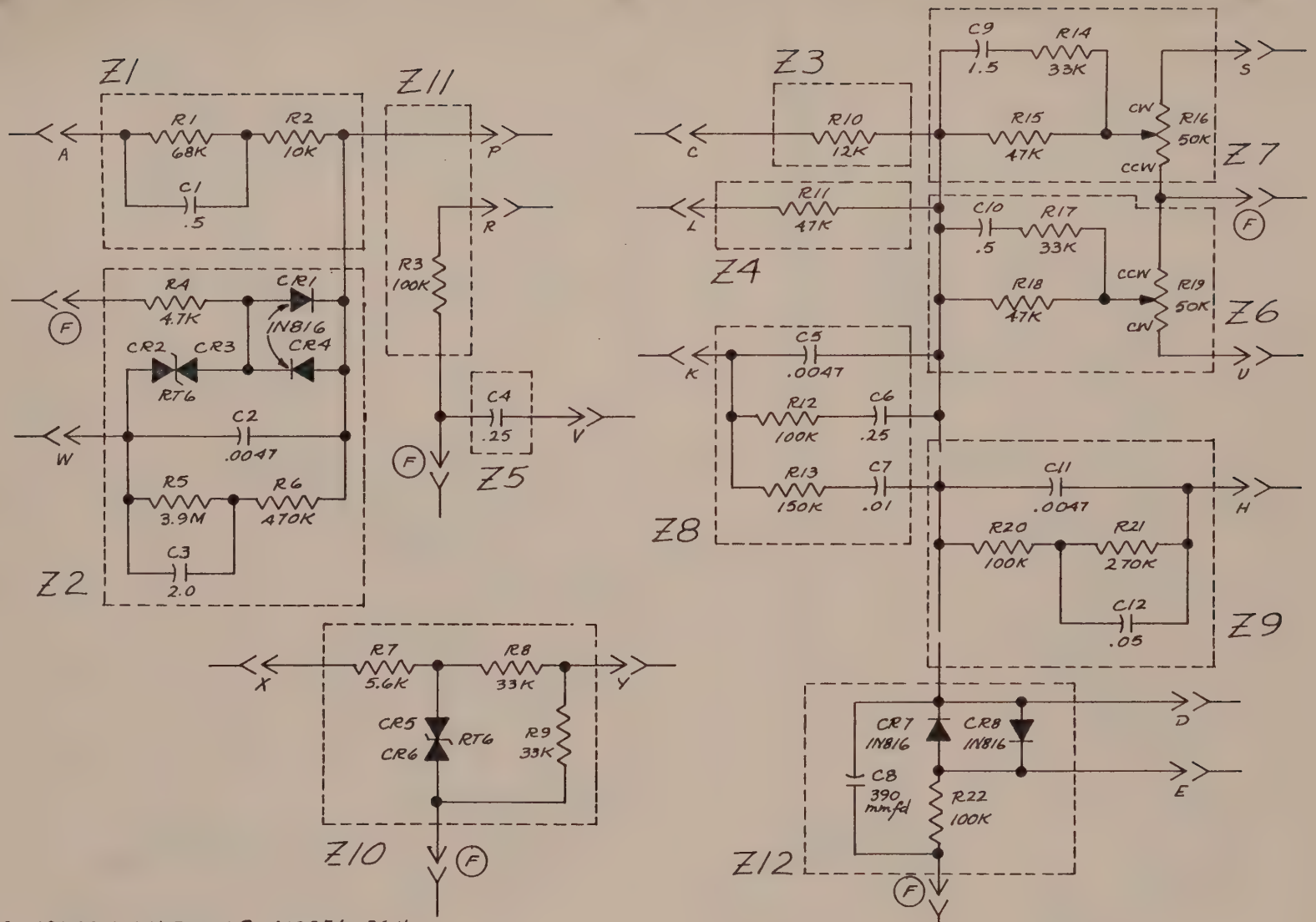


CONTROL UNIT SN 7 MODEL 3611

1. (F) ALL THESE TIE TO SAME PIN F.

NOTE:

Fig. 7.10.1. DC Amplifier Compensation Cards Schematic Diagram (Heavy Pedestal)

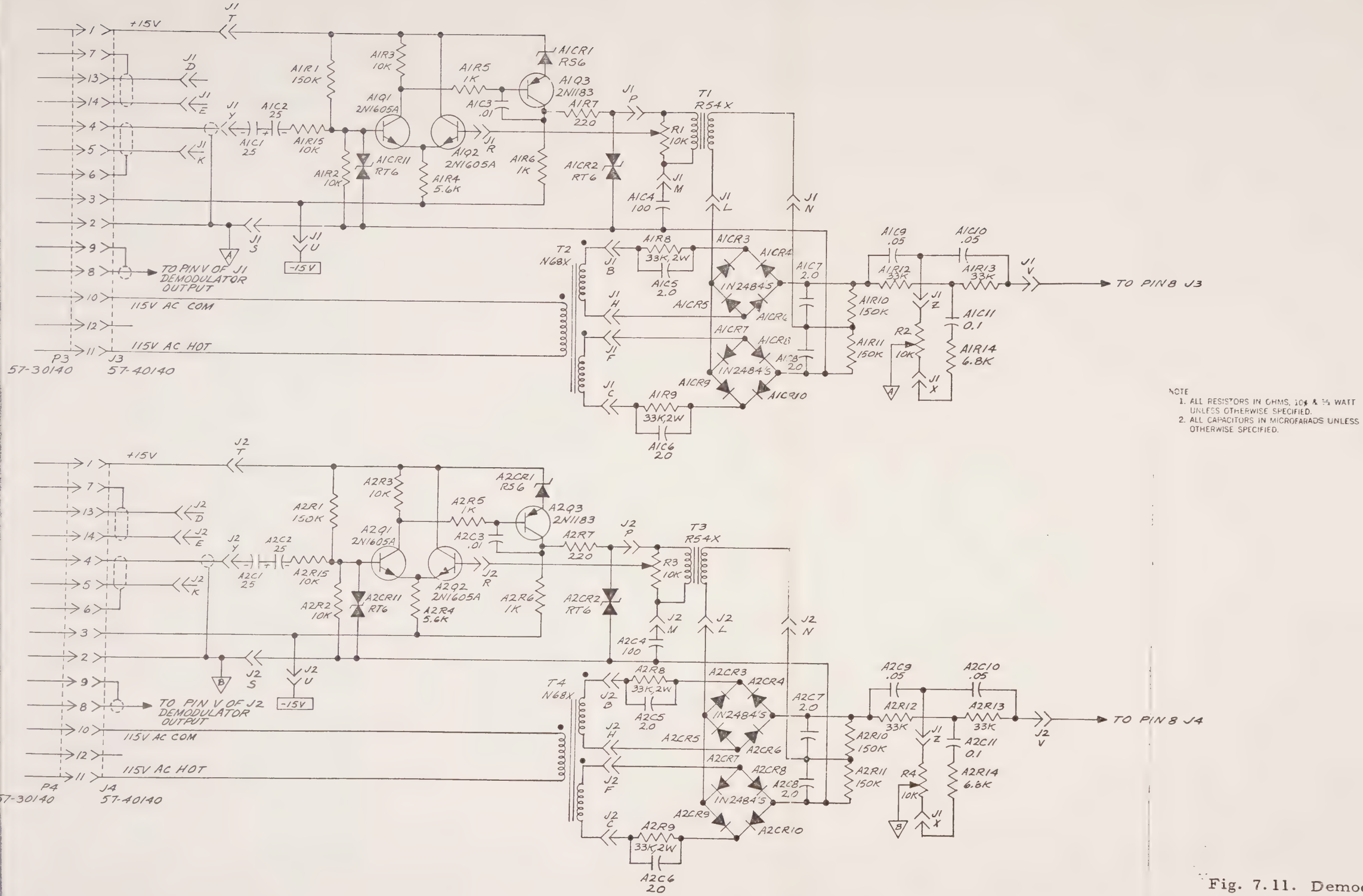


2 CONTROL UNIT S/N 8 MODEL 3611

1. (F) ALL THESE TIE TO SAME PIN F.

NOTE:

Fig. 7.10.2. DC Amplifier Compensation Cards Schematic Diagram (Light Pedestal)



NOTE
1. ALL RESISTORS IN OHMS, 10% & ½ WATT UNLESS OTHERWISE SPECIFIED.
2. ALL CAPACITORS IN MICROFARADS UNLESS OTHERWISE SPECIFIED.

Fig. 7.11. Demodulator Schematic Diagram

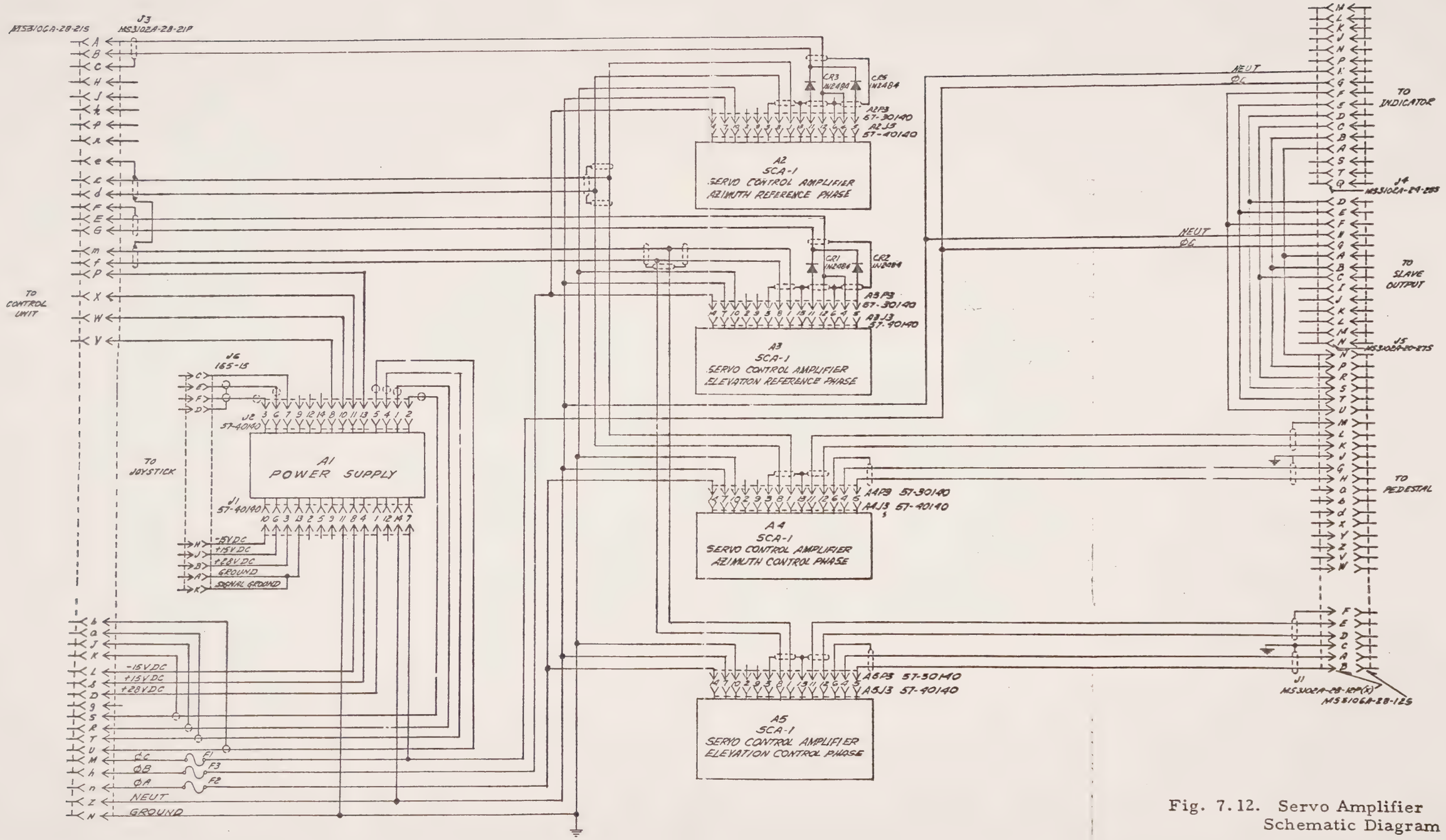


Fig. 7.12. Servo Amplifier Schematic Diagram

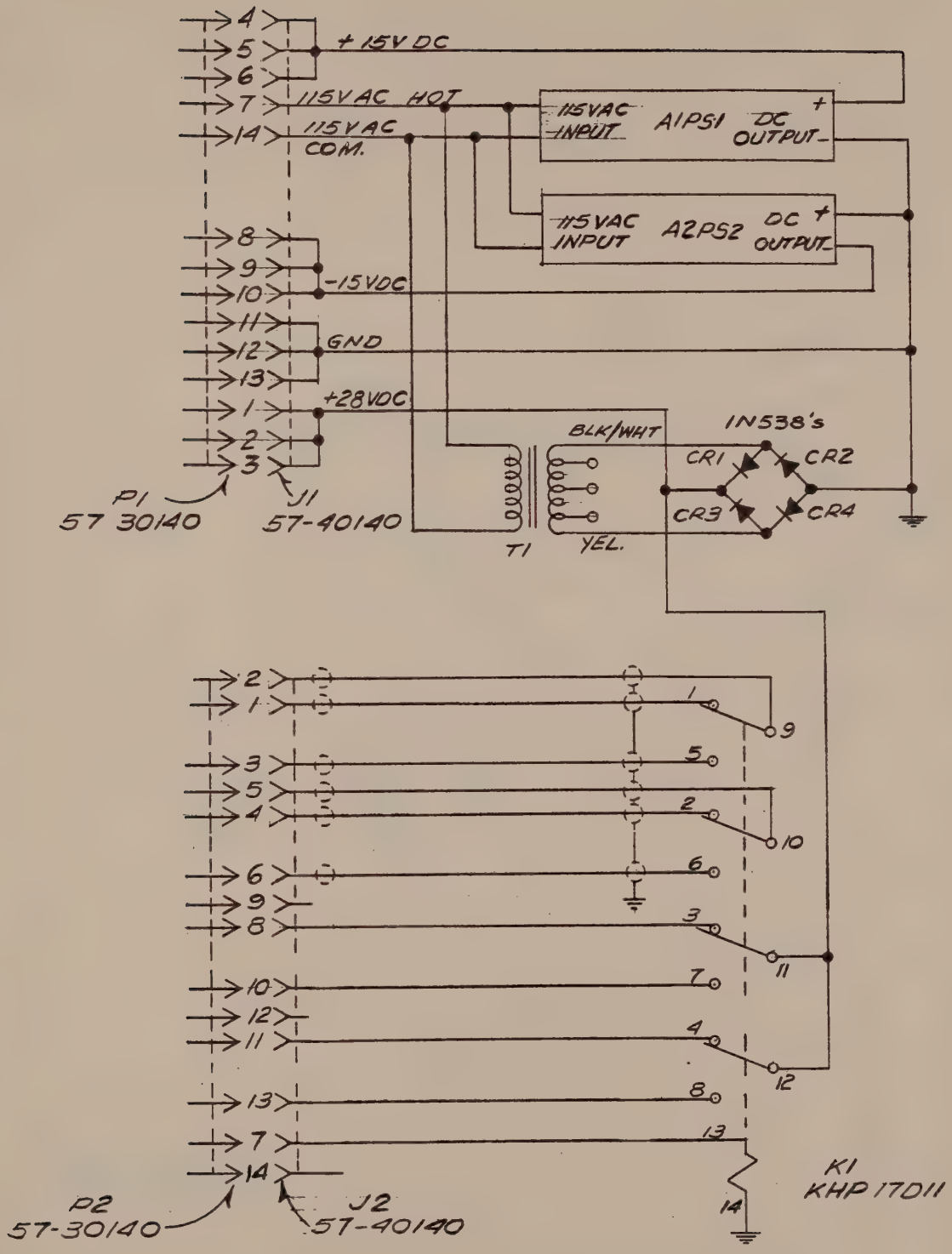
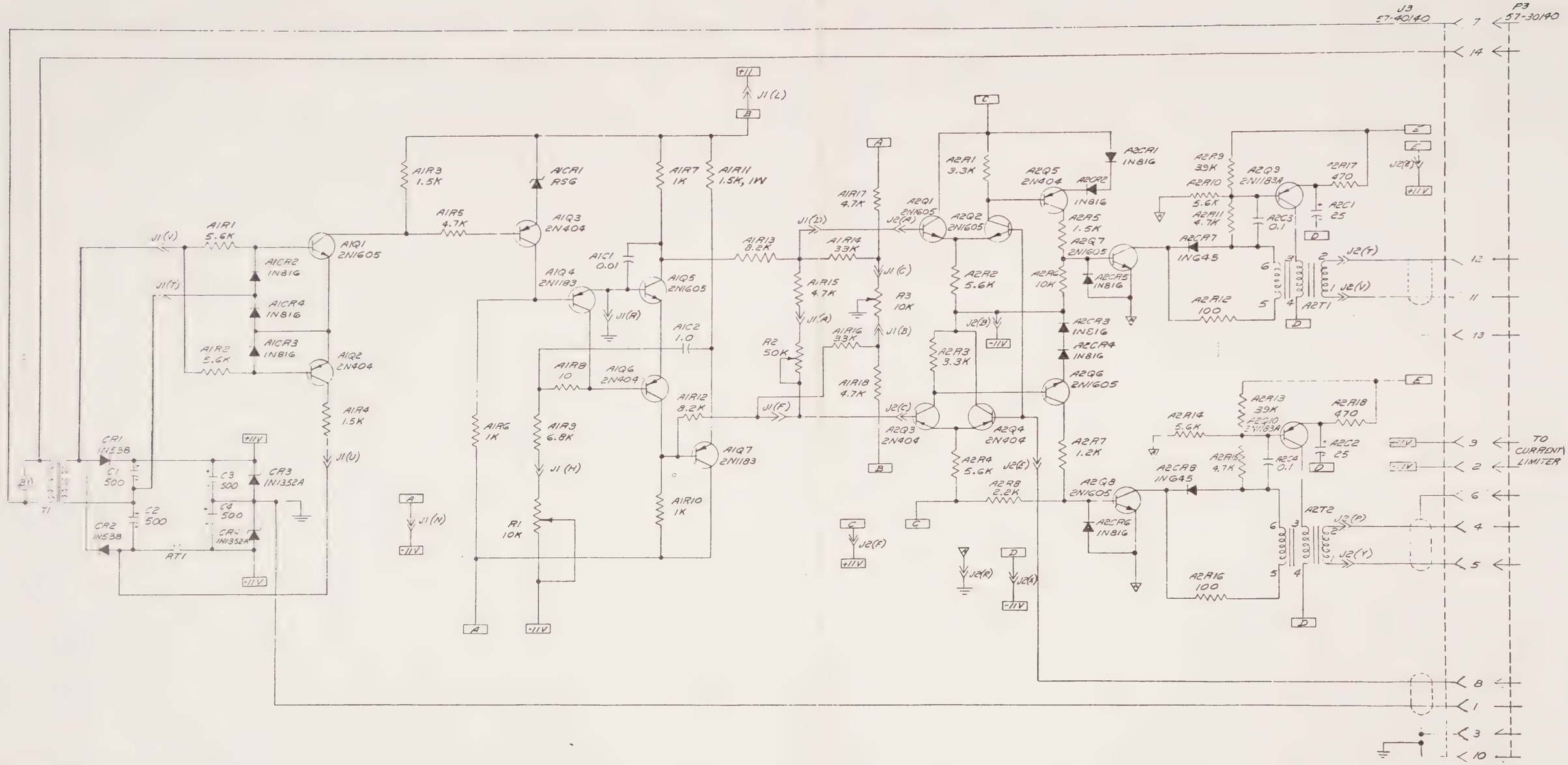


Fig. 7.13. Servo Amplifier Power Supply Schematic Diagram



NOTE
1. ALL RESISTORS IN OHMS, 10% & ½ WATT UNLESS OTHERWISE SPECIFIED.
2. ALL CAPACITORS IN MICROFARADS UNLESS OTHERWISE SPECIFIED.

Fig. 7.14. Servo Control Amplifier Schematic Diagram

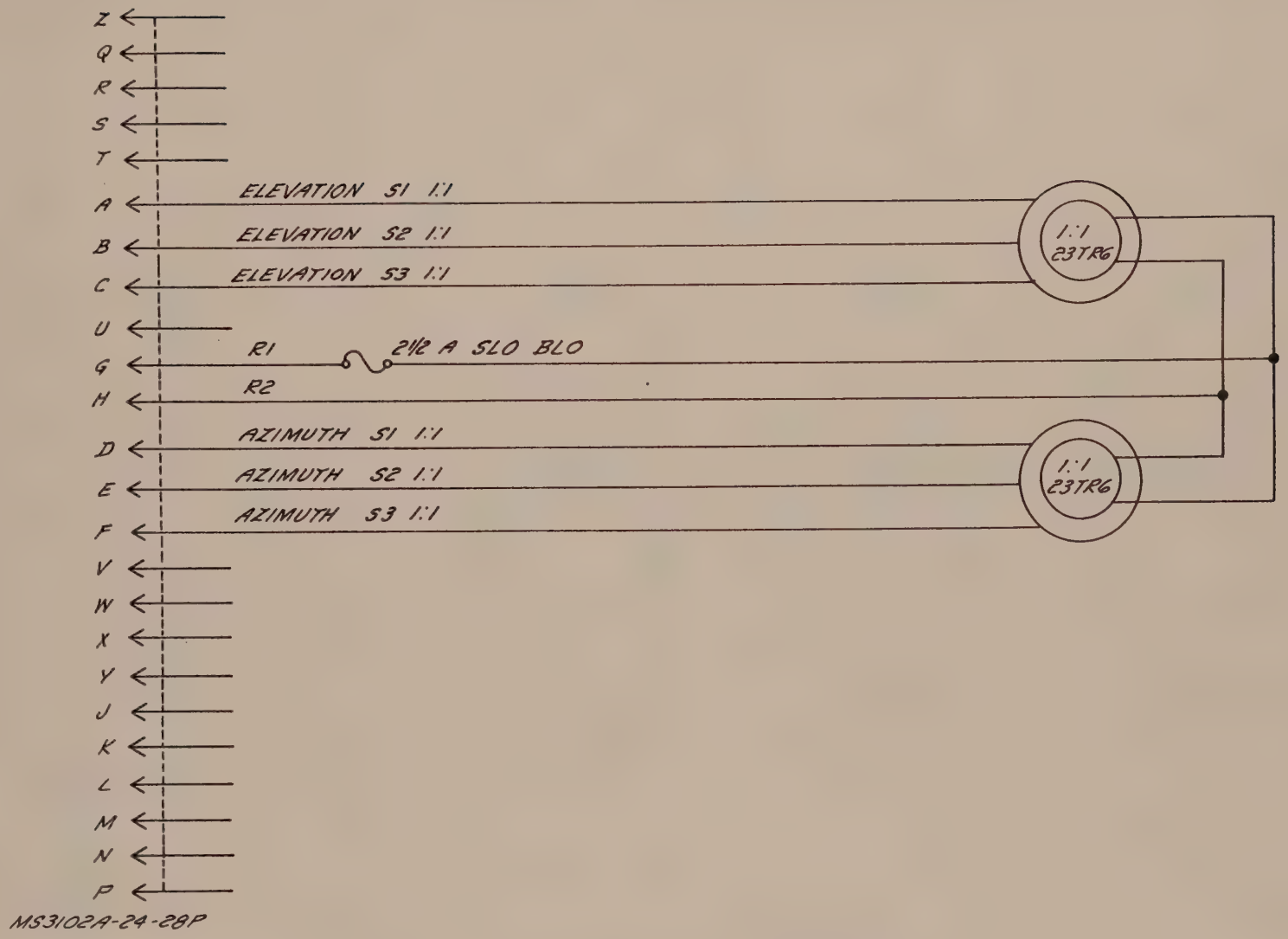


Fig. 7.15. Position Indicator Schematic Diagram

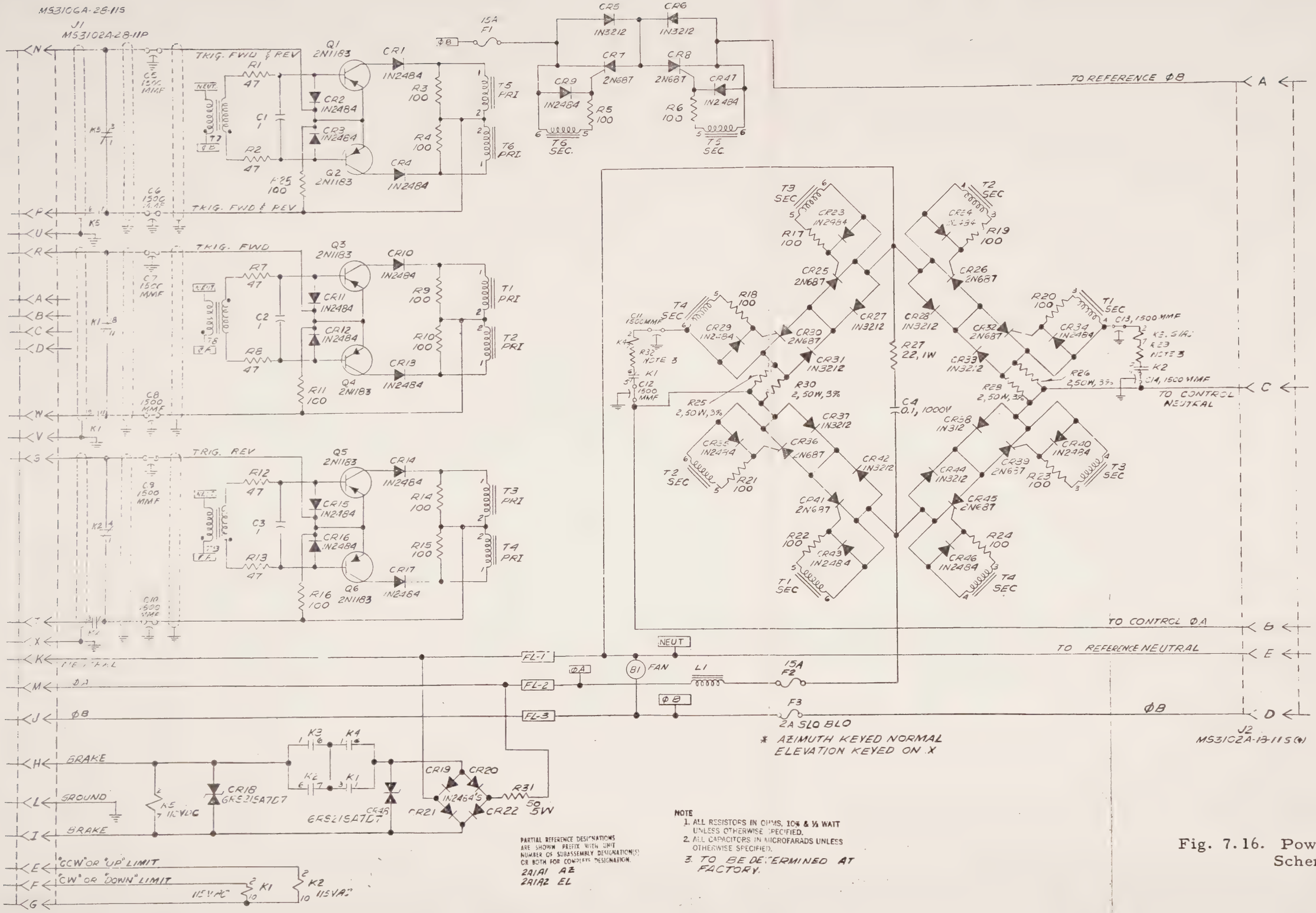


Fig. 7.16. Power Amplifier Schematic Diagram

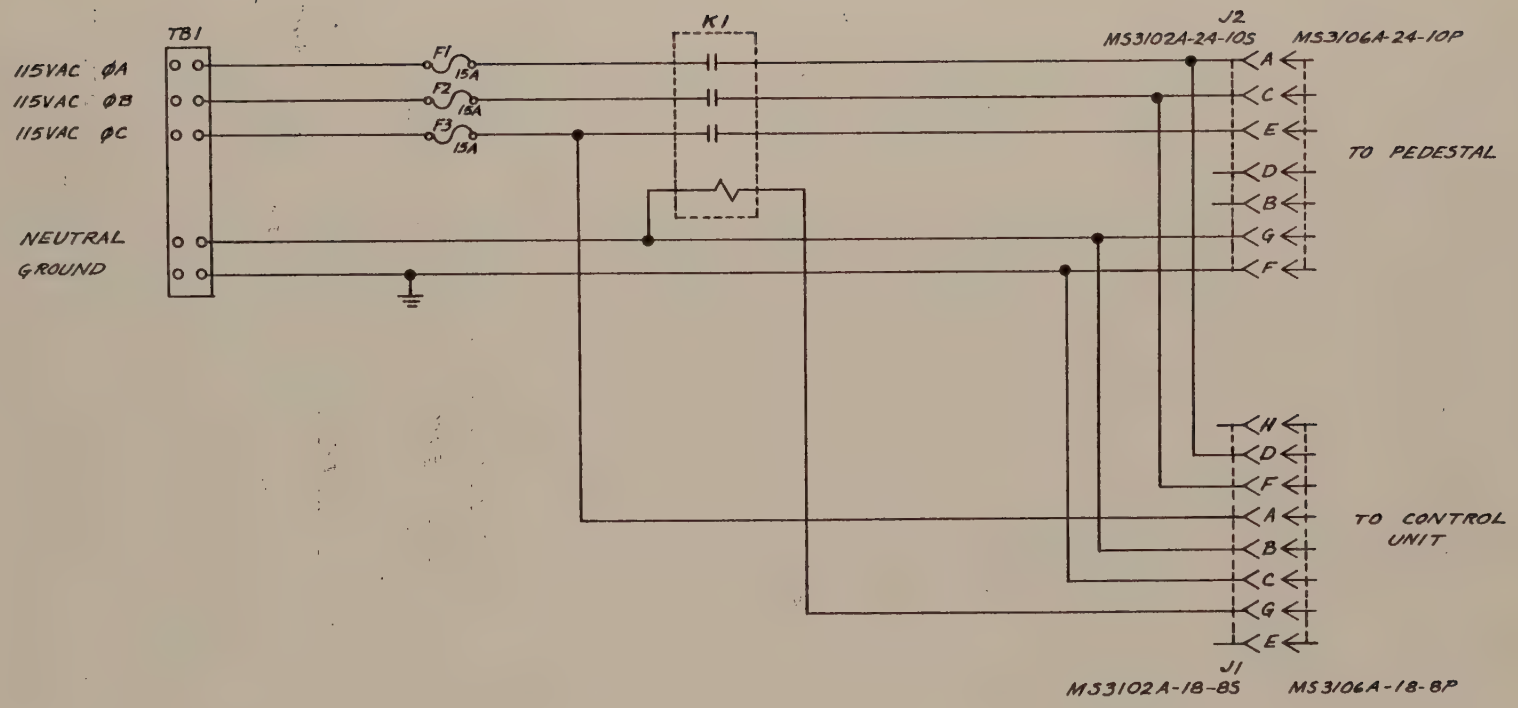


Fig. 7.17. Power Control Box Schematic Diagram